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CH2MHILL

24 October 2013

Mr. Jonathan S. Davis
Remediation Program Manager
HQ AFCEC/JBCC
322 East Inner Road
Otis ANG Base, MA 02542-5028

SUBJECT: AFCEC FA8903-08-D-8769-0365; Task Order 0365
MMR SPEIM/LTM/Optimization Program
CDRL #A001p
Final 4th Five Year Review, 2007-2012, Massachusetts Military Reservation Superfund Site, Otis Air National Guard Base, MA

Dear Mr. Davis:

As directed by the Air Force Civil Engineer Center, CH2M HILL is hereby distributing copies of the *Final 4th Five Year Review, 2007-2012, Massachusetts Military Reservation Superfund Site, Otis Air National Guard Base, MA* dated October 2013. Enclosed are four bound copies, one unbound copy and three compact disc (CD) copies. Copies are also being sent to the appropriate agencies.

If you have any questions or comments, please contact Jon Davis at (508) 968-4670, extension 4952.

Sincerely,

CH2M HILL

N. Tindall

Nigel Tindall, P.G.
Project Manager

Enclosures: (4 bound, 1 unbound & 3 CDs)

c. Rose Forbes, AFCEC/JBCC
772d ESS/PKJ (1 w/o attach.)
Bob Lim, EPA (1 bound, 1 CD)
Lynne Jennings, EPA (1 CD)
Erin Sanborn, EPA/OSSR RIC (1 bound, 1 CD)
Leonard Pinaud, MassDEP (1 bound, 1 CD)
Henry Ciu, MassDEP (1 CD)
Elliot Jacobs, MassDEP (1 CD)
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Massachusetts Military Reservation

Final
4^{th} Five Year Review, 2007-2012
Massachusetts Military Reservation (MMR)
Superfund Site
Otis Air National Guard Base, MA

October 2013

Prepared for:
AFCEC/MMR
Installation Restoration Program
322 E. Inner Road
Otis ANGB, MA 02542

Prepared by:
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Otis ANGB, MA 02542

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ACRONYMS AND ABBREVIATIONS

ABB-ES	ABB Environmental Services, Inc.
AFCEC	Air Force Civil Engineer Center
AFCEE	Air Force Center for Engineering and the Environment
AFOMS/SGPR	Air Force Office of Medical Support
ANG	Air National Guard
AOC	area of concern
ARAR	applicable or relevant and appropriate requirement
ARNG	Army National Guard
ASI	Advanced Sciences Inc.
AST	aboveground storage tank
ATSDR	Agency for Toxic Substances and Disease Registry
AV	Ashumet Valley
AVGAS	aviation gasoline
bgs	below ground surface
BOH	Board of Health
BOMARC	Boeing Michigan Aerospace Research Center
BSVR	biosparge/vapor recovery
BTEX	benzene, toluene, ethylbenzene, xylene
CCl_4	carbon tetrachloride
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (Superfund)

ACRONYMS AND ABBREVIATIONS

CERCLIS	Comprehensive Environmental Response, Compensation, and Liability Information System
cfm	cubic feet per minute
CIA	Central Impact Area
CMR	Code of Massachusetts Regulations
COC	contaminant of concern
COPC	contaminant of potential concern
CS	Chemical Spill
CSM	conceptual site model
CWMA	Crane Wildlife Management Area
CWSW	Coonamessett Water Supply Well
CY	Coal Yard
DDT	dichlorodiphenyltrichloroethane
DEQE	Department of Environmental Quality Engineering
DoD	Department of Defense
DPDO	Defense Property Disposal Office
DSRP	Drainage Structure Removal Program
EDB	ethylene dibromide
EE/CA	Engineering Evaluation/Cost Analysis
EPA	U.S. Environmental Protection Agency
EPH	extractable petroleum hydrocarbon
ERA	Ecological Risk Assessment
ESD	Explanation of Significant Difference

ACRONYMS AND ABBREVIATIONS

ETD	extraction, treatment, and discharge
ETI	extraction, treatment, and infiltration
ETR	extraction, treatment, and reinjection
FFA	Federal Facility Agreement
FIW	Fighter-Interceptor Wing
FS	Fuel Spill
FTA	Fire Training Area
ft	feet/foot
ft^2	square feet/foot
GAC	granular activated carbon
gpm	gallons per minute
GP	Gun Position
HA	Health Advisory
HATF	Hunter Avenue Treatment Facility
HEC	hazard equivalent concentration
HI	hazard index
IAGWSP	Impact Area Ground Water Study Program
IP	In-Plume
IRIS	Integrated Risk Information System
IROD	Interim Record of Decision
IRP	Installation Restoration Program
JP-4	Jet Propulsion-4
lbs	pounds

ACRONYMS AND ABBREVIATIONS

LF	Landfill
LTM	long term monitoring
LUC	Land Use Control
MassDEP	Massachusetts Department of Environmental Protection
MassDPH	Massachusetts Department of Public Health
MCL	Maximum Contaminant Level
MCP	Massachusetts Contingency Plan
MDFW	Massachusetts Division of Fisheries and Wildlife
MEC	munitions and explosives of concern
mg/kg	milligrams per kilogram
MMCL	Massachusetts Maximum Contaminant Level
MMR	Massachusetts Military Reservation
MMRCT	MMR Cleanup Team
Mn	manganese
MNA	monitored natural attenuation
MNX	hexahydro-1-nitroso-3,5-dinitro-1,3,5-triazine
msl	mean sea level
MTU	mobile treatment unit
NCL	North-Central lobe
NCP	National Contingency Plan
NDIL	Non-Destructive Inspection Laboratory
NGB	National Guard Bureau
NL	Northern lobe

ACRONYMS AND ABBREVIATIONS

NPL	National Priorities List
NWOU	Northwest Operable Unit
O&M	operations and maintenance
OWS	oil/water separator
PA	Preliminary Assessment
PAH	polycyclic aromatic hydrocarbon
PAWS	Phased Array Warning System
PCB	polychlorinated biphenyl
PCE	tetrachloroethene
pCi	picoCuries
PCM	post-closure monitoring
PEST	Parameter Estimation
PFSA	Petroleum Fuels Storage Area
PRA	preliminary risk assessment
PWSW	Public Water Supply Well
RAL	remedial action level
RAO	Remedial Action Objective
RAR	Remedial Action Report
RBC	risk-based concentration
RCRA	Resource Conservation and Recovery Act
RDX	Royal Demolition Explosive or hexahydro-1,3,5-trinitro-1,3,5-triazine
RI	remedial investigation

ACRONYMS AND ABBREVIATIONS

ROD	Record of Decision
RSL	Regional Screening Level
SD	Storm Drain
SI	site inspection
SITM	Site Inspection Technical Memorandum
SL	Southern lobe
SLR	Summary Letter Report
SPEIM	System Performance and Ecological Impact Monitoring
SRTF	Sandwich Road Treatment Facility
SSI	Supplemental Site Inspection
STCL	soil target cleanup level
STP	sewage treatment plant
SVE	soil vapor extraction
SVOC	semivolatile organic compound
SWOU	Southwest Operable Unit
SWP	shallow wellpoint
TBC	To Be Considered
TCE	trichloroethene
TMB	trimethylbenzene
TPH	total petroleum hydrocarbon
TRET	Technical Review and Evaluation Team
USACHPPM	U.S. Army Center for Health Promotion and Preventive Medicine
USAF	U.S. Air Force

ACRONYMS AND ABBREVIATIONS

USAFSAM/OEC	U.S. Air Force School of Aerospace Medicine
UCRTS	Upper Cape Regional Transfer Station
USCG	U.S. Coast Guard
USGS	U.S. Geological Survey
UST	underground storage tank
UTES	Unit Training Equipment Site
UU/UE	unlimited use and unrestricted exposure
VC	vinyl chloride
VI	vapor intrusion
VOC	volatile organic compound
VPH	volatile petroleum hydrocarbon
WWII	World War II
µg/kg	micrograms per kilogram
µg/L	micrograms per liter
1,1,1-TCA	1,1,1-trichloroethane
1,1,2,2-TeCA	1,1,2,2-tetrachloroethane
1,4-DCB	1,4-dichlorobenzene

EXECUTIVE SUMMARY

The U.S. Air Force conducted a Five Year Review of the remedies implemented at the Installation Restoration Program sites at the Massachusetts Military Reservation Superfund Site, located on western Cape Cod in Barnstable County, Massachusetts. The sites were reviewed because hazardous substances, pollutants, or contaminants remaining at one or more of the sites are above levels that allow for unlimited use and unrestricted exposure. The purpose of the five-year review is to determine whether the remedial actions implemented at each site remain protective of human health and the environment. In total, six source area sites (Section 4.0) and 14 groundwater plumes/sites (Section 5.0) were assessed in this Five Year Review. After issuance of the last CERCLA Five Year Review (covering the period October 2002 through September 2007), AFCEC and the regulatory agencies have determined that the 1988 decision document for the Coal Yard-2 source area site was not fully executed and, therefore, no remedy has been established. As such, Coal Yard-2 will not be subject to a protectiveness determination in this Five Year Review. However, for completeness, the recommendations from the last CERCLA Five Year Review and associated background information and site status for Coal Yard-2 will be addressed in this document.

The remedies at two of the six source area sites (Landfill-1 and Landfill-7) are considered protective of human health and the environment due to the implemented remedial actions. The remedies for the remaining four source area sites evaluated in this Five Year Review are protective of human health and the environment in the short-term based on current land use. Actions related to the implementation of land use controls and/or completion of exposure assessments related to vapor intrusion are recommended for the remedies at these sites for them to be protective in the long term.

The remedies at all 14 groundwater sites evaluated in this Five Year Review are considered protective of human health and the environment due to the implemented remedial actions including the full implementation of the land use controls which occurred during this five year review period. The primary actions recommended for the groundwater plumes/sites are related to assessment of emerging contaminants and further evaluation of restoration timeframe discrepancies between current projections and the expectations at the time of the completion of the Records of Decision. An abbreviated summary of the issues and recommendations/follow up actions for the source area and groundwater plume/sites evaluated in this Five Year Review are included in the Five Year Review Summary Form at the end of this Executive Summary. More detailed summaries of the recommendations/follow up actions are included in **Table 1-4** and detailed descriptions are included

in each of the site/plume specific narratives in Sections 4.0 and 5.0. A summary of the protectiveness statements for the source area sites and groundwater plumes/sites is included in **Table 1-5**.

The triggering action for the statutory Five Year Review process for the Massachusetts Military Reservation Superfund Site began with the initiation of the remedial action on-site construction date of the Chemical Spill-4 treatment system on October 15, 1992. As a result of this triggering action, the first Five Year Review, covering the period 1992-1997, was published in March 1999. Subsequently, the second and third Five Year Reviews, covering the periods 1998-2002 and 2002-2007 were published in May 2003 and September 2008, respectively. This is the fourth Five Year Review for the Massachusetts Military Reservation Superfund Site and covers the period from October 2007 through September 2012. However, for some source area sites and all the groundwater sites, data and information collected after September 2012 were considered in the development of the recommendation, follow up actions, and protectiveness determinations. The following source area sites rely on data and/or information collected after September 2012: Landfill-1 (annual landfill inspection completed in October 2012); Fire Training Area-2 (long-term monitoring groundwater sampling event completed in December 2012/January 2013); and Landfill-7 (annual landfill inspection completed in October 2012). For the groundwater plumes/sites, remedial system performance monitoring data was considered through December 2012; and data/information collected post-September 2012 under the Land Use Control Private Well Verification Program was paramount in the development of the protectiveness determinations.

Prior to the selection of a remedy, remedial investigations and assessments of the nature and extent of contamination were conducted. Based on the results of these investigations, remedial action objectives were selected for each Installation Restoration Program site. These objectives were then used to select the remedial actions for the site that are detailed in site-specific decision documents. During the five year review, the selected action is reviewed for its continued ability to achieve its goal of protection of human health and the environment, implementation, and system operation and maintenance (if applicable).

Data and information collected since the last Five Year Review were reviewed against the remedial action objectives for each site, trends in contaminant concentrations, changes in contaminant distribution, remedial system performance at sites with active treatment, land use, and status and performance of institutional controls.

FIVE YEAR REVIEW SUMMARY FORM

SITE IDENTIFICATION		
Site Name: Massachusetts Military Reservation Superfund Site		
EPA ID: MA2570024487		
Region: 1	**State:** MA	**City/County:** Barnstable County

SITE STATUS	
NPL Status: Final	
Multiple OUs? Yes	**Has the site achieved construction completion?** Yes

REVIEW STATUS
Lead agency: Other Federal Agency **If "Other Federal Agency" was selected above, enter Agency name:** U.S. Air Force
Author name: Various – Refer to Section 1.3
Author affiliation: CH2M HILL
Review period: 01 October 2007 – 30 September 2012
Date of site inspection: 19 June 2013 and 10 July 2013
Type of review: Statutory
Review number: 4
Triggering action date: September 2008 (submittal date of Third Five Year Review)
Due date *(five years after triggering action date)*: September 2013

Issues/Recommendations
OU(s) without Issues/Recommendations Identified in the Five-Year Review:
Source Area Sites: LF-1, LF-7; Groundwater Sites: CS-19, FS-1, FS-13, FS-28, FS-29
Issues and Recommendations Identified in the Five-Year Review:
See following table for abbreviated summary of issues and recommendations by site and Table 1-4 for a detailed summary by site.

FIVE YEAR REVIEW SUMMARY FORM

Site Name	Issue Description	Recommendation/ Follow-Up Actions
Source Area Sites		
CS-10/FS-24 Detail C and F	LUC/long-term protectiveness	Reassess soil data for UU/UE.
	Exposure assessment	Complete VI evaluation
FTA-2/LF-2	LUC/long-term protectiveness	Submit Focused Feasibility Study
	LUC/long-term protectiveness	File deed notification and document in ROD Amendment
PFSA (FS-10/FS-11)	LUC/long-term protectiveness	Submit Focused Feasibility Study
	Exposure assessment	Complete VI evaluation.
SD-4	LUC/long term protectiveness	Prepare a RAR and ESD
	Exposure assessment	Complete VI evaluation
Groundwater Sites		
Ashumet Valley, CS-4, CS-10, CS-20, CS-21, CS-23, LF-1, and SD-5	Emerging contaminants	Develop sampling and analysis plan
CS-4	Restoration timeframe discrepancy	Re-run transport simulation and present results
CS-10	Restoration timeframe discrepancy	Submit draft ESD to document optimization of treatment system
FS-12	Restoration timeframe discrepancy	Update EDB plume shell and complete a remedial system optimization assessment
LF-1/CS-23	Restoration timeframe discrepancy	Update plume shells and complete a remedial system optimization assessment
	Increasing TCE concentration at CS-23 monitoring well	Re-assess plume boundary and LUC boundary and present results
	Potential ecological impacts from system operation	Continue monitoring
SD-5	Restoration timeframe discrepancy	Prepare an ESD

FIVE YEAR REVIEW SUMMARY FORM

Protectiveness Statement(s)	
See Table 1-5 for Protectiveness Statements by site.	
Site wide Protectiveness Statement (if applicable)	
For sites that have achieved construction completion, enter a site wide protectiveness determination and statement.	
Protectiveness Determination: Protective/Short-term Protective	*Addendum Due Date (if applicable):* Not applicable
Protectiveness Statement: Site wide, the remedies are either protective or short-term protective – see Table 1-5 for a summary by site.	

Key:
CS = Chemical Spill
ESD = Explanation of Significant Difference
FS = Fuel Spill
FTA = Fire Training Area
LF = Landfill
LUC = Land Use Control
PFSA = Petroleum Fuel Storage Area
RAR = Remedial Action Report
ROD = Record of Decision
SD = Storm Drain
TCE = trichloroethene
UU/UE = unlimited use/unrestricted exposure
VI = vapor intrusion

1.0 INTRODUCTION

The U.S. Air Force (USAF) conducted a Five Year Review of the remedies implemented at Installation Restoration Program (IRP) sites at the Massachusetts Military Reservation (MMR) Superfund Site, located on western Cape Cod in Barnstable County, Massachusetts, approximately 60 miles south of Boston and immediately south of the Cape Cod Canal (**Figure 1-1**). The sites were reviewed because hazardous substances, pollutants, or contaminants remaining at one or more of the sites are above levels that allow for unlimited use and unrestricted exposure (UU/UE). The general locations of the IRP sites are shown in **Figure 1-2**.

Since 1990, the USAF IRP has managed the characterization and remediation of the contamination at the MMR. The Comprehensive Environmental Response, Compensation, and Liability Information System number for the MMR site is MA2570024487. The MMR was formally added to the National Priorities List (NPL) in 1989. A Federal Facilities Agreement (FFA), which provided the legal framework for investigating and remediating numerous operable units at the MMR, was signed in 1991 (EPA et al. 1991). In 1996, the FFA was amended to add the USAF as the lead agency for the cleanup at MMR (EPA et al. 2002). The FFA, as amended, requires the USAF to implement Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) requirements at MMR. In addition to the USAF, the U.S. Environmental Protection Agency (EPA) and National Guard Bureau (NGB) are parties to the FFA for the MMR. The Air Force Civil Engineer Center (AFCEC)[1] is managing the soil and groundwater contamination sites under the IRP in accordance with CERCLA as required by the Defense Environmental Restoration Program. The Massachusetts Department of Environmental Protection (MassDEP) is not a signatory of the FFA, but is an active participant in the cleanup process and provides guidance and direction to the process. The USAF and EPA have jointly selected the remedies for these sites. The MassDEP has concurred with the selected remedies (AFCEE 2008, 2011).

[1]In October 2012, the Air Force Center for Engineering and the Environment (AFCEE) adopted a new organizational name, the Air Force Civil Engineer Center (AFCEC). Therefore, the AFCEE and AFCEC acronyms refer to the same entity, but are used in this document in relation to the date of the specific topic/document.

1.1 PURPOSE OF THE REVIEW

The purpose of the Five Year Review is to evaluate the implementation and performance of a site cleanup remedy in order to determine if the remedy is or will be protective of human health and the environment. The EPA guidance for Five Year Reviews (EPA 2001) requires each site be evaluated and three questions answered regarding the protectiveness of the cleanup actions that have occurred or are occurring at the Site. These three questions are:

A. Is the remedy functioning as intended by the decision documents?
B. Are the exposure assumptions, toxicity data, cleanup levels, and remedial action objectives used at the time of the remedy still valid?
C. Has any other information come to light that could call in to question the protectiveness of the remedy?

For the purposes of this Five Year Review, the word "Site" (capital "S") refers to the collection of all the individual source areas and groundwater sites at the MMR that are being cleaned up pursuant to the FFA for the MMR Superfund Site, signed July 17, 1991 and its amendments under the IRP (EPA et al, 1991, 2002).

Each individual site was evaluated following the EPA Five Year Review guidance (EPA 2001) and the recent supplement addressing the vapor intrusion (VI) pathway (EPA 2012a) and clarification memorandum on the use of protectiveness determinations (EPA 2012b). The methods, findings, and conclusions of the reviews are documented within this Five Year Review report. In addition, this Five Year Review report identified certain issues found during the review and identified specific recommendations to address them.

1.2 AUTHORITY FOR CONDUCTING THE FIVE YEAR REVIEW

The USAF is the designated lead agency for this Five Year Review. This Five Year Review report was prepared pursuant to CERCLA of 1980 (Superfund) §121 and the National Contingency Plan (NCP). CERCLA §121 states:

> *If the President selects a remedial action that results in any hazardous substances, pollutants, or contaminants remaining at the Site, the President shall review such remedial action no less often than each five years after the initiation of such remedial action to assure that human health and the environment are being protected by the remedial action being implemented. In addition, if upon such review it is the judgment of the President that action is appropriate at such Site in accordance with section [104] or [106], the President shall take or require such action. The President shall report to the Congress a list of facilities for which such review is required, the results of all such reviews, and any actions taken as a result of such reviews.*

EPA interpreted this requirement further. In the NCP, 40 Code of Regulations (CFR) §300.430(f)(4)(ii) states:

> *If a remedial action is selected that results in hazardous substances, pollutants, or contaminants remaining at the Site above levels that allow for unlimited use and unrestricted exposure, the lead agency shall review such action no less often than every five years after the initiation of the selected remedial action.*

In addition to these statutory categories of Five Year Review, section 1.2.1 of EPA's guidance also provides for policy-based Five Year Reviews:

> *Five-year reviews generally should be conducted as a matter of policy for following types of actions:*
>
> - *A . . . remedial action that, upon completion, will not leave hazardous substances, pollutants, or contaminants on site above levels that allow for unlimited use and unrestricted exposure, but requires five years or more to complete . . . ;*
> - *A removal-only site on the NPL where a removal action leaves hazardous substances, pollutants, or contaminants on site above levels that allow for unlimited use and unrestricted exposure and where no remedial action has or will take place.*

1.3 WHO CONDUCTED THE FIVE YEAR REVIEW

CH2M HILL was retained by the USAF to conduct the Five Year Review under AFCEC contract FA890308D8769, Task Order 0337. This review was conducted from October 2012 through July 2013 for the MMR IRP Superfund Site located on Cape Cod, Massachusetts.

The CH2M HILL Five Year Review team included Mr. Nigel Tindall (project manager and Ashumet Valley and FS-28 plume lead), Mr. John Tunks (task manager and senior technical consultant), CH2M HILL groundwater plume leads (Mr. Jason Dalrymple, Ms. Mary O'Reilly, and Mr. Mark Hilyard), and CH2M HILL risk assessor (Ms. Barrie Selcoe). The team was assisted by Mr. Jon Davis (AFCEC MMR Remedial Program Manager), Ms. Rose Forbes (AFCEC MMR Project Manager and Contracting Officers Representative), and Mr. Doug Karson (AFCEC Community Involvement Lead). Input also was provided by base contractors, the EPA, and the MassDEP.

1.4 REVIEW REFERENCE AND TRIGGERING ACTION

This is the fourth Five Year Review for the MMR IRP Superfund Site, covering the period from October 2007 through September 2012. The triggering action for the statutory review process for MMR began with the initiation of the remedial action on-site construction date of the Chemical Spill No.4 (CS-4) treatment system on October 15, 1992. As a result of this triggering action, the first Five Year Review, covering the period 1992-1997 (AFCEE 1999), was published in March 1999. Subsequently, the second and third Five Year Reviews, covering the periods 1998-2002 (AFCEE 2003) and 2002-2007 (AFCEE 2008) were published in May 2003 and September 2008, respectively.

1.5 AREAS/SITES ADDRESSED WITH THIS FIVE YEAR REVIEW

MMR IRP sites have been divided into three general categories. The three categories of sites are as follows:

- IRP Sites Not Requiring a Five Year Review: These sites have been closed without restrictions and, therefore, will be excluded from this and future Five Year Reviews. **Table 1-1a** is a comprehensive list of the MMR IRP sites that have been closed since the last Five Year Review and includes the rationale for why each of these 27 sites no longer needs to be included in the Five Year Review process; further details are provided in Section 3.1. **Table 1-1b** contains a listing of all sites that have been closed without restriction as documented in this and prior Five-Year Reviews. The sites not requiring a Five Year Review (74 in total) are identified on **Figure 1-2** by the green shaded areas.

- IRP Source Area Sites Requiring a Five Year Review: These sites require a Five Year Review because they are under investigation, remedial action has not been completed; or the site has restricted use. Section 4.0 presents MMR IRP source area sites that require a Five Year Review. The source area sites are identified on **Figure 1-2** by the orange shaded areas. **Table 1-2** lists the Source Area IRP sites that are addressed in this Five Year Review. Summaries of the decision status for each of these sites are also presented in **Table 1-2**. After issuance of the last CERCLA Five Year Review (AFCEE 2008), AFCEC and the regulatory agencies have determined that the 1988 decision document for the Coal Yard-2 (CY-2) source area site was not fully executed and, therefore, no remedy has been established. As such, CY-2 will not be subject to a protectiveness determination in this Five Year Review. However, for completeness, the recommendations from the last CERCLA Five Year Review and associated background information and site status for CY-2 will be addressed in this document.
- IRP Groundwater Sites Requiring a Five Year Review: These sites require a Five Year Review because they are under Remedial Action - Operation status. The 14 MMR IRP groundwater sites that require a Five Year Review are presented in Section 5.0 and shown on **Figure 1-2** and **Figure 1-3**. **Table 1-3** lists the Groundwater IRP sites that are addressed in this Five Year Review. Summaries of the decision status for each of these sites are also presented in **Table 1-3**.

1.6 ADMINISTRATIVE AND GLOBAL COMPONENTS OF FIVE YEAR REVIEW PROCESS

According to the EPA guidance, the Five Year Review must, for each Site:

- *describe the Site's chronology and background,*
- *summarize the remedial actions that have taken place at the Site,*
- *describe the progress in the CERCLA cleanup process that has taken place at the Site since the last review (if applicable),*
- *outline the actual five-year review process conducted on the Site,*
- *do a technical assessment of the Site,*
- *describe any issues arising from the review process,*
- *make recommendations and follow-up actions needed at the Site, and*
- *provide a statement of protectiveness for the Site.*

Under EPA policy, if cleanup at a site is deferred to a corrective action order under another statute (such as the Resource Conservation and Recovery Act [RCRA] or the Safe Drinking Water Act), it is not necessary to conduct a Five Year Review. Therefore, the contaminated sites at MMR that are being cleaned up by the MMR Impact Area

Ground Water Study Program (IAGWSP), pursuant to the EPA Region 1 Administrative Order, under the authority of the Safe Drinking Water Act, are not included in this report. It should be noted, however, that a separate Five Year Review was conducted by the IAGWSP for their sites in 2013.

This Five Year Review report covers multiple remedies and operable units in the MMR cleanup program. Regardless of whether operable units or areas of concern are active or inactive, each MMR IRP site was evaluated according to the EPA guidance for Five Year Reviews. The status and progress of each site in the CERCLA cleanup process was considered in each evaluation. **Figure 1-4** is a flow diagram that shows how this process works. The primary focus of this document is the technical assessment and any subsequent issues and required follow-up actions that relate to the continued protectiveness of the cleanup actions associated with each site subject to this Five Year Review. The following subsections are major components of the Five Year Review.

1.6.1 Document and Data Review

This Five Year Review consisted of a review of relevant documents including operations and maintenance (O&M) records and manuals, health and safety plans, sampling and analysis plans, monitoring data and monitoring reports, applicable cleanup standards, remedial investigation (RI) reports, and decision documents.

A summary of information about each site has been provided for background purposes in Sections 4.0 (source areas) and 5.0 (groundwater). Each site's history is outlined, explaining what occurred at the site and how it became contaminated, if this information is known. In addition, the specific actions that were taken at each site, from investigation through cleanup, are also summarized.

References are provided to all documents supporting the history, investigations, and cleanup decisions for each site. Individual reports are located in the official Administrative Record of the MMR IRP Superfund Site. This record is physically maintained at the MMR IRP Offices, located in Building 322 on Otis Air National Guard

(ANG) Base, Massachusetts. In addition, the public libraries in the four towns surrounding MMR can help locate and obtain copies of specific documents using their on-line reference systems. Finally, an electronic copy of the index of the MMR IRP Administrative Record documents is maintained at the Bourne Public Library.

1.6.2 Technical Assessments

Technical assessments were made of every site requiring a Five Year Review to determine the current level of protectiveness of the cleanup actions that have occurred or are occurring at each site. The three questions listed in Section 1.1 guided these technical reviews.

For sites where a remedy is still functioning, Question A requires an assessment of whether the remedy is still functioning as intended by the decision documents. This assessment was done by examining the histories of the groundwater treatment system annual reports, the source area treatment system operating reports (as applicable), and the status of any institutional control procedures required by the decision documents.

Question B requires that the assumptions and criteria used when the decisions were made to do the remedial actions and to eventually close the sites be reexamined using today's standards. Question C requires the Remedial Program Manager to examine any other information that may have come to light regarding the protectiveness of the selected remedy and the decision to close the site. These two questions apply to all sites that do not meet UU/UE conditions.

In doing these technical assessments, all the cleanup levels that were factored in the decisions for these sites were checked against current cleanup levels to make sure that a more conservative remedial action objective cleanup standard would not now be required. If a Maximum Contaminant Level (MCL) that was used in an on-going or completed cleanup action has now become more restrictive, then the affected decision would have to be reevaluated using today's standards and adjustments to the cleanup process for that site would have to be made.

The technical assessments used information gathered during the routine surveillance of MMR soils and groundwater over the reporting period, as well as inputs from the community via the MMR Cleanup Team (MMRCT), to determine if conditions along the exposure pathways and at the receptors, for example, had changed at any of the sites. Examples of typical situations that would drive a reassessment of the remedy's effectiveness and protectiveness would be a shift in a groundwater plume's direction of migration or a change in land and/or resource use in the vicinity of a source area or groundwater plume. Again, the visibility of the MMR IRP activities assures these kinds of changes are routinely identified and their consequences considered.

The public plays a vital role in the oversight of the MMR IRP cleanup program. Information from the community regarding these sites, or potential new sites, was evaluated and considered in the technical assessments.

1.6.3 Community Involvement

Public notices were published in the local newspapers listed below on the dates specified:

Bourne Enterprise (17 January 2013),
Falmouth/Mashpee/Sandwich Enterprises (18 January 2013), and
Cape Cod Times (18 January 2013).

These notices announced the start of the Five Year Review process and specified that updates on the Five Year Review would be given at future meetings with the MMRCT which are open to the public. The notice also indicated the expected schedule for completion of the Five Year Review and stated that the final report would be available in the main libraries of the four towns that surround the MMR. Finally, contact information for the AFCEC Community Involvement Lead was provided. A copy of this announcement is provided in **Appendix A**.

On 09 January 2013, Mr. Jon Davis presented an overview and schedule for the Five Year Review process to the MMRCT. The public was given a complete overview of the Five Year review process and encouraged to contact AFCEC if they had questions,

comments or suggestions concerning the MMR remediation program. A follow-up presentation to the MMRCT on the findings of the Five Year Review is planned following the submittal of this final Five Year Review report. In addition, AFCEC plans to prepare a fact sheet summarizing the findings of this Five Year Review for submittal in Fall 2013.

1.6.4 Summary of Issues, Recommendations, and Follow-up Actions

During the process of the Five Year Review, some specific issues were identified at certain sites. Although none of these issues put the overall short-term protectiveness of any of the remedies in jeopardy, these issues are important to long-term protectiveness and provide thorough documentation of site decisions and conditions. As a result, recommendations and follow-up actions were made as part of this review and are summarized in **Table 1-4**. A summary of the protectiveness statements for each of the sites subject to this Five Year Review is included in **Table 1-5**. Although none of the issues identified in **Table 1-4** adversely affect the status of the short-term protectiveness of any of the sites, the resulting recommendations will be tracked through the regular activities of the MMR IRP stakeholder groups, which include community advisors and regulators.

1.7 NEXT FIVE YEAR REVIEW

The next Five Year Review for the MMR IRP Superfund Site is required by September 2018, five years from the date of the final previous Five Year Review document and will cover the period 01 October 2012 through 30 September 2017.

1.8 REPORT ORGANIZATION

Section 1.0 provides an introduction to this Five Year Review and Section 2.0 provides an overview to the MMR Superfund Site that is subject on this Five Year Review. Section 3.0 presents a summary of the MMR IRP sites that have met UU/UE requirements since the last Five Year Review and presents an overview of global issues or activities that are common to all of the IRP source area and/or groundwater sites

addressed in this Five Year Review. Sections 4.0 and 5.0 provide the Five Year Review assessment findings including answering the three protectiveness questions and providing the protectiveness statement for the IRP source areas, and groundwater plumes, respectively. A matrix that cross references the EPA Comprehensive Environmental Response, Compensation, and Liability Information System (CERCLIS) Operable Unit Numbers to the IRP site names and document section is provided in **Table 1-6**. **Appendix A** includes a copy of newspaper announcement of the commencement of MMR IRP Five Year Review Process; **Appendix B** includes site inspection (SI) reports; **Appendix C** includes a detailed data review that supports assessment of the Storm Drain-4 (SD-4) source area site (Section 4.7); **Appendix D** includes technical evaluations for select private wells assessed under the Land Use Control (LUC) program as part of this Five Year Review; and **Appendix E** includes documentation on regulator comment resolution and concurrence letters.

1.9 REFERENCES

AFCEE. 2011 (September). *Final Explanation of Significant Differences for the Installation Restoration Program Groundwater Plumes at the Massachusetts Military Reservation*. 389849-SPEIM-Multiple-RPT-001. Prepared by CH2M HILL for AFCEE/MMR, Installation Restoration Program, Otis ANG Base, MA.

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EPA. 2012a (November). Assessing Protectiveness at Sites for Vapor Intrusion (Supplement to the Comprehensive Five-Year Review Guidance). OSWER Directive 9200.2-84.

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EPA Region I and the United States Department of Defense, National Guard Bureau. 1991 (and subsequently amended). *Federal Facility Agreement Under CERCLA § 120 and RCRA § 7003* In the matter of: The U.S. Department of Defense, National Guard Bureau, Massachusetts Military Reservation, Cape Cod, MA.

2.0 MMR OVERVIEW

2.1 SITE LOCATION AND DESCRIPTION

The MMR IRP Superfund Site is located on western Cape Cod in Barnstable County, Massachusetts, approximately 60 miles south of Boston and immediately southeast of the Cape Cod Canal. The MMR occupies approximately 22,000 acres within the towns of Bourne, Falmouth, Mashpee, and Sandwich. The MMR is organized into four principal functional areas:

Range Maneuver and Impact Area. This area consists of approximately 16,000 acres occupying the northern 70 percent of MMR and is used for training and maneuvers as part of the Army National Guard's (ARNG) Camp Edwards.

Cantonment Area. This area consists of approximately 5,000 acres in the southern portion of MMR and is the location for all or part of the administrative, operational, maintenance, housing, and support facilities and the flightline for Otis ANG Base, U.S. Coast Guard (USCG) Air Station Cape Cod, and Camp Edwards.

Massachusetts National Cemetery. This area consists of approximately 750 acres along the western edge of MMR and contains the Veterans Affairs cemetery and support facilities.

Cape Cod Air Station. This area occupies 100 acres of the northern portion of the Range Maneuver and Impact Area and consists of the USAF fixed base phased array warning system known as PAVE Phased Array Warning System (PAWS).

2.2 LAND USE AND SITE HISTORY

Military use of portions of MMR began as early as 1911. From 1911 to 1935, the Massachusetts National Guard periodically camped to conduct maneuvers and weapons training in portions of the Shawme Crowell State Forest. In 1935, the Commonwealth of Massachusetts purchased the area now occupied by MMR for permanent training facilities. Most of the activity at MMR has occurred since 1935, including operations by the U.S. Army, the U.S. Navy, USCG, USAF, Massachusetts ARNG, Massachusetts ANG, and the Veterans Affairs.

In general, two different types of operations have dominated military activity at MMR: (1) mechanized army training, maneuvers, and maintenance support (Camp Edwards) and (2) military aircraft operations, maintenance, and support [Otis Army Air Field/Air Force Base/Coast Guard Air Station]. The level of activity has varied over the MMR operational history. The most intensive U.S. Army activity occurred during World War II (WWII) (1940-1944) and during demobilization following the war. During the last two years of WWII, the U.S. Navy used the MMR runways, flightline, and housing areas for advanced naval aviation carrier-based flight training.

The most intensive air craft operations occurred from 1955 to 1970, when large numbers of surveillance and air defense aircraft operated from MMR. Then, the USAF operated 45 EC-121 (Super Constellation) Airborne Early Warning and Control aircraft and a Fighter-Interceptor Wing (FIW) from MMR.

A major military hospital was in operation at MMR from WWII to 1970. Immediately following WWII, the hospital was a major orthopedic rehabilitation center. In the early 1970s, the hospital was decommissioned and demolished.

The intensive periods of activity occurred under separate organizational control and were staged in two separate portions of the Cantonment Area. The WWII period of activity occurred under U.S. Army control when MMR had been federalized and was known as Camp Edwards. Large-scale motor pool activities and troop billeting occurred in the center of the Cantonment Area. These operations were carried out in units surrounding a central parade ground, as bounded on four sides by West, South, East, and North Inner Roads. During WWII, air operations at Otis Army Airfield were reportedly of a relatively low level of intensity. The most intensive aircraft operations occurred along the expanded flightline areas located in the southeastern portion of the Cantonment Area, under USAF control. From 1960 to 1973, a Boeing Michigan Aeronautical Research Center (BOMARC) air defense missile installation was located at the MMR (see Section 4.1 for more details). During the 1970s, the Strategic Air Command also used the runways at MMR to park refueling aircraft.

In 1970, the airborne surveillance activity was phased out. The air defense mission was carried on by the USAF until 1973, when this mission, as well as management of the base, was transferred to the 102^{nd} FIW of the Massachusetts ANG. In March 1992, the 102^{nd} was redesignated the 102^{nd} Fighter Wing; and in April 2008, under Base Realignment and Closure initiatives, was redesignated the 102^{nd} Intelligence Wing. The mission of the 102^{nd} was also revised to provide world-wide precision intelligence, and command and control along with trained and experienced Airmen for expeditionary combat support and homeland security.

Other major operations have been ongoing at MMR. The ARNG and U.S. Army Reserve training has been carried out at variable levels since the early 1950s. The USCG began operations at Air Station Cape Cod at MMR in 1970. Since 1978, the USAF has operated the PAVE PAWS missile and space vehicle tracking system from Cape Cod Air Force Station, located at the northern end of MMR, and in 1978, the Veterans Affairs acquired 750 acres in the western portion of MMR to develop the Massachusetts National Cemetery, which began operations in 1980. There are five major organizations now using MMR. They are the Massachusetts ARNG, operating Camp Edwards; the ANG/Massachusetts ANG, operating Otis ANGB; the USAF, operating Cape Cod Air Force Station; the USCG, operating Air Station Cape Cod; and the Veterans Affairs, operating the Massachusetts National Cemetery.

Activities at MMR that had the potential for contaminating the environment included the storage, handling, and disposal of solvents and petroleum fuels as well as the leakage of these materials into storm water drainage systems and the sanitary sewer system. Landfill operations, firefighter training, coal and ash storage, sewage treatment, and numerous chemical and fuel spills have also resulted in environmental contamination of both soil and groundwater.

3.0 GLOBAL ISSUES FOR SOURCE AREA AND GROUNDWATER PLUME SITES

3.1 STATUS OF SOURCE AREA SITES FOR UU/UE CLOSURE

The third Five Year Review included a listing of 27 source area sites that are no longer subject to Five Year Reviews and recommended that the majority of remaining source area sites be evaluated to determine if they are eligible for UU/UE (AFCEE 2008a). If the UU/UE criterion is met, then those sites too would not be subject to future Five Year Reviews. Four separate technical memorandums (AFCEC 2013a, b, c, d) have been prepared to examine the existing data and present newer data where applicable to demonstrate the source area sites that qualify for UU/UE. A listing of the sites and a short description of the UU/UE justification are presented in **Table 1-1a**. Source area sites that did not qualify for UU/UE are included in this Five Year Review (**Table 1-2** and Section 4.0).

It should be noted that some of the source area sites listed in **Table 1-1a** are located over the CS-10 groundwater plume (**Figure 1-2**). For these source area sites, the UU/UE determination applies to the surface and/or subsurface soil and these sites do not have any groundwater issues. However, access to groundwater at these sites is still restricted under the CS-10 Record of Decision (ROD)-mandated LUC requirements (Section 5.3). Although these source area sites are no longer subject to Five Year Reviews, CS-10 groundwater will continue to be assessed in future Five Year Reviews.

Two sites (CS-18 and CS-19 source) will no longer be addressed in the CERCLA-mandated Five Year Reviews for the MMR. The CS-18 and CS-19 source areas underwent remedial actions as reported in the *Final CS-18 Decision Document* (AFCEE 2009a) and the *Final CS-19 Soil Removal Action Report* (AFCEE 2009b). Since the sites are on an active range and may have munitions and explosives of concern (MEC) remaining, the sites do not meet UU/UE conditions. No additional source area action is planned under CERCLA and any training-related munitions or residual sources may be addressed under EPA Safe Drinking Water Act Administrative Orders or other future range cleanup activities.

3.2 VAPOR INTRUSION

The VI exposure pathway has been considered in the past in some of the risk assessments prepared for the IRP sites during the RI/feasibility study phase of the CERCLA process. However, the last MMR IRP Five Year Review (AFCEE 2008a) contained a recommendation to complete a more comprehensive and consistent VI evaluation for the various IRP groundwater plumes due to the more recent increased regulatory focus on the VI exposure pathway and the advances in the science of VI.

In response to this recommendation, the potential for VI was assessed (or re-assessed if a prior assessment was completed during the RI) for each of the 14 IRP groundwater sites (evaluated in Section 5.0) and at the Petroleum Fuel Storage Area (PFSA) and Fire Training Area (FTA-2)/Landfill-2 (LF-2) source area sites where residual petroleum-related soil and groundwater contamination remains (see Sections 4.4. and 4.6). The VI assessment process initially involves determining whether there is a potentially complete VI exposure pathway associated with each groundwater or soil site where volatile contaminants remain. If a potentially complete VI exposure pathway is identified, a preliminary screening step is completed. The results of this screening step were used to determine if further investigation is necessary to evaluate whether VI risk above target levels is likely or unlikely. The results of the VI evaluation are detailed in the *Final 2011 MMR Vapor Intrusion Evaluation Technical Memorandum* (AFCEE 2012a) and are also summarized in each of the applicable Five Year Review subsections that cover the sites included in the VI assessment. The VI assessment completed for the IRP sites referred to above meets the requirements presented in the EPA Five Year Review supplemental guidance *Assessing Protectiveness at Sites for Vapor Intrusion* (EPA 2012a). In addition, the remaining source area sites that are subject to this Five Year Review (CS-10 Details C and F, Coal Yard [CY]-2, LF-1, LF-7, and SD-4) were assessed following the VI pathway evaluation process presented in the 2012 VI technical memorandum. The results of this VI pathway screening including recommendations for further evaluation at two source area sites (CS-10 and PFSA) following updated VI screening guidance that is focused on petroleum release sites are included in each of the corresponding source area discussions in Section 4.0.

3.3 LAND USE CONTROLS

3.3.1 Land Use Control Requirement for IRP Source Area Sites

The majority of the IRP source area sites are located within the installation fence line and many have met UU/UE conditions as documented in prior Five Year Reviews (AFCEE 2008a, 2003, 1999) and as summarized in **Tables 1-1a** and **1-1b**. Within the installation fence line, sites have typically been designated as "outside the flightline" (such as the LF-1 source area) and "inside the flightline" (such as the FTA-2 source area) (**Figure 1-2**). In general, surface soil for "outside the flightline" sites were evaluated based on a future residential exposure scenario. Subsurface soil was either evaluated based on worker exposure scenario or not evaluated based on disposal practices at the site. It should be noted that for some sites, regardless of the depth of contamination in subsurface soil, a worker exposure scenario was used for the risk assessment. "Inside the flightline" sites were evaluated based on a worker exposure scenario for both surface and subsurface soil. Based on current land use, restricted access to the base, and land use and management that is strictly controlled by military entities, the remedies for the source area sites subject to this Five Year Review are protective in the short-term. However, for any source area or exposure pathway (e.g., subsurface soil) within that source area where hazardous substances, pollutants, or contaminants remain or may remain above levels that allow for UU/UE exposure and institutional controls are not in place, additional cleanup and/or enforceable LUCs may be necessary to ensure long-term protectiveness. Specific recommendations related to the need for LUCs are included in each of source area narratives presented in Section 4.0.

3.3.2 Land Use Control Requirement for IRP Groundwater Sites

Each of the groundwater sites assessed in Section 5.0, except for CS-19 and FS-13, are located partially or entirely outside the boundaries of the MMR (**Figures 1-2** and **1-3**). These off-base groundwater plume areas are located in four different towns: Bourne, Sandwich, Mashpee, and Falmouth; some groundwater plumes (e.g., CS-10) are located in more than one town.

The AFCEC, EPA, and MassDEP have coordinated with the four towns in past years to develop town-specific groundwater use regulations issued through the towns' respective Boards of Health (BOH). Additionally, AFCEC has provided municipal water service and/or household connections to homes in the areas of the groundwater plumes that were previously serviced by private wells. During the development of the RODs for CS-23 and LF-1 in the summer of 2007 (AFCEE 2007a and 2007b), AFCEC and the regulatory agencies agreed that the BOH regulations and ancillary enforcement procedures were not adequate to ensure the prevention of potential exposure to contaminated groundwater from the MMR plumes. Examples of potential exposure include: residents using former private drinking water wells for irrigation, filling of swimming pools, or car washing; parcels with more than one home using a combination of private wells and municipal water supply; or residents that declined earlier offers from AFCEC for connection to a municipal water supply.

As a result of these discussions, the groundwater site RODs and Explanation of Significant Differences (ESDs) (**Table 1-3**) contain specific procedures that require the Air Force to verify the private well status of all parcels within the plume footprints. The well verification requirements (modified to read generically for all off-base MMR plumes) follow:

Within three years of the signing of the ROD or ESD, the Air Force shall:

a. Document all private wells (i.e., non-decommissioned wells, including wells not currently in use) that are above or within the projected path of the plume(s).
b. Demonstrate and document that the private well is not capable of drawing contaminated groundwater originating from the plume(s), or test the private well for contamination and demonstrate the private well to be safe for human use. The Air Force will continue such testing, on an appropriate frequency as determined in coordination with the EPA and MassDEP, until the plume(s) no longer presents a threat to that well as determined in coordination with EPA and MassDEP.
c. If the Air Force identifies a well containing contaminants of concern (COCs), the Air Force shall assess the risk that current and potential future non-drinking uses of the well may pose to human health. The Air Force shall submit a draft version of any such risk assessment to EPA and MassDEP for review and concurrence.

d. If neither b nor c is able to confirm that the identified well is safe for human use, the Air Force will offer the owner decommissioning of the well. If accepted, the Air Force will document such action with the appropriate BOH. If the decommissioning is not accepted, the Air Force will take other steps to insure protectiveness to include, but not be limited to, requesting assistance from the appropriate BOH to issue health warnings to the property owner and any other person with access to the well (such as a lessee or licensee), offering bottled water (if well is used for drinking), or installing treatment systems on affected wells. In each instance, the Air Force shall submit a schedule subject to EPA and MassDEP concurrence, outlining and including time limitations for the completion of steps sufficient to prevent exposure to concentrations of contaminated groundwater from the plume(s) having carcinogens in excess of applicable or relevant and appropriate requirements (ARARs) (i.e., MCLs, non-zero MCL goals), and prevent exposure to groundwater from the plume(s) that poses a cancer risk in excess of the EPA target risk range of 10^{-4} to 10^{-6} or which presents a non-carcinogenic hazard index greater than one.

The Air Force has developed a guideline for implementing this requirement titled *Verification, Decommissioning, and Documentation Guidelines for Private Wells in Areas of Potential Concern* (AFCEE 2008b). Additionally, the Air Force developed and is using a LUC database to record the status of the well verification process and subsequent results for the over 2,077 parcels located in plume areas. The database is capable of producing a variety of reports and is being shared with the regulatory agencies and officials at the BOH for each of the four towns. As reported in Section 5.0 of this Five Year Review, the initial well verification and well determination process required by the RODs and/or ESDs has been completed by AFCEC. Outreach has been completed at all of the 2,077 parcels currently included in the LUC database. As a result of this outreach, 493 private residential wells have been identified. Of the 493 wells identified, six are used to supply drinking water, 145 are actively used for outdoor purposes such as irrigation or washing cars, and 348 are currently not in use. Based on technical evaluations, well determinations were made that concluded that none of the identified private wells represent a current unacceptable exposure risk to the IRP groundwater plumes. Further details are provided in the groundwater site evaluations presented in Section 5.0. Continued monitoring at two private wells used as a drinking water supply is being conducted by AFCEC; these wells are associated with the CS-20 (Section 5.5) and LF-1 (Section 5.13) groundwater plumes. Additionally, one private well used for outdoor purposes associated with the CS-10 plume (Section 5.3) is being monitored

annually. In addition to these private residential wells, nine commercial or agricultural irrigation wells are monitored routinely under the LUC Program by AFCEC.

This Five Year Review has determined that the remedies in place for groundwater sites are protective in the short-term since there is no evidence that there is current, unacceptable exposure to contaminated groundwater including through the use of the private wells identified during the LUC well verification process. However, in order to ensure long-term protectiveness while remedial actions associated with the groundwater plumes are ongoing, AFCEC will continue to assess data collected under the IRP's System Performance and Ecological Impact Monitoring/Long-Term Monitoring (SPEIM/LTM) program to determine whether these actively used private wells identified through the well verification and well determination process represent an unacceptable exposure risk. In the event that new private well information is obtained or plume monitoring data indicate a change to the conceptual site model (CSM) for each plume, AFCEC will perform the necessary well determinations at the time the information becomes available with the objective of determining whether protectiveness is being maintained. These protectiveness determinations for active private wells located near the IRP groundwater plumes will be included in future Five Year Reviews.

The status of non-operational private wells will continue to be tracked. AFCEC will distribute a mailing, on an annual basis, to property owners within each LUC area that have inactive or decommissioned wells for which no technical evaluation could be completed due to lack of known well depths and inability to sample. The intent of the annual mailing is to remind these property owners that they should contact AFCEC for a technical evaluation, which may include sampling, in the event their well is put back into service. In addition to these annual mailings, AFCEC will perform outreach as part of future Five Year Reviews to each of the property owners requiring confirmation of the non-operational status of their wells. This outreach effort will result in positive contact with each of the property owners (i.e., responses from all property owners via returned survey forms, e-mail, telephone or site visit) to document the operational status of these non-operational or decommissioned wells. If any of these wells are determined through

outreach to have been returned to service, AFCEC will perform a technical evaluation for that well. The results of this outreach and any resultant technical evaluations will be documented in future Five Year Reviews (AFCEC 2013e).

3.4 GLOBAL ESD FOR THE IRP GROUNDWATER SITES

An ESD (AFCEE 2011) was prepared during this Five Year Review period to document changes to the selected remedies for the IRP groundwater plumes addressed in Section 5.0 of this report and shown on **Figure 1-3**. The RODs that prescribe the final remedies for these groundwater sites are summarized in **Table 1-3**. These RODs were developed over an approximate ten-year period. During that time, refinements and revisions were made to the language used in each of the RODs at MMR based on discussions and negotiations with stakeholders and legal counsel. These refinements are generally recognized as providing more descriptive clarity to the remedies described in each ROD. In general, the changes included in the ESD were designated into four different groupings as follows:

1. Revisions to the phrasing of Remedial Action Objectives (RAOs);
2. Revisions to the phrasing of LUCs;
3. Clarifying the inclusion of monitored natural attenuation (MNA) as a component of the selected remedies; and
4. Adding and revising text regarding the MMR Three-Step Process for each site which describes the anticipated steps that will need to be completed to achieve site closure.

While at least one of the grouping changes summarized above applied to each of the groundwater site RODs, not all of the grouping changes applied to every ROD. ROD-specific applicability of each of the grouping changes is described in detail for each of the groundwater sites in Section 5.0 of this Five Year Review.

3.5 SITE INSPECTIONS

SIs have been completed for each of the source area sites addressed in Section 4.0 that require a Five Year Review. A summary of the findings is included in each source area

evaluation and completed SI forms are provided in **Appendix B**. In addition, **Table 3-1** provides a summary of the site inspection findings, planned corrective actions including responsible party, and whether any issues affect protectiveness. It is noted that no issues were identified at any of the source area sites that required corrective action or affect protectiveness. Routine annual inspections required as part of the LUC programs at LF-1 and LF-7 will continue.

Similar to prior Five Year Reviews, SIs for the 14 groundwater sites evaluated in this Five Year Review were not conducted because these sites, and the associated remedial systems for the plumes with active treatment, are routinely inspected (daily during the work week) as part of the ongoing O&M activities by AFCEC's full time O&M contractor. Any operational or other issues, such as operational downtime, are immediately reported to the regulatory agencies via operational status e-mails. Restart notifications are also provided via e-mail. The IRP remedial systems are operated and maintained under an approved O&M Plan (AFCEE 2012b). The O&M Plan is updated on an annual basis and includes operational requirements, a summary of the operational history of the systems, and details of any system modifications, optimizations, or improvements. While occasional operational issues are identified, these issues have been, and continue to be, addressed in a timely and effective manner such that O&M associated with the remedy is considered effective at achieving the remedy goals. O&M data and activities are summarized in O&M monthly reports and system performance and reliability is reported in annual Summary Letter Reports (SLRs) which are submitted to the regulatory agencies.

3.6 INTERVIEWS

Similar to the last Five Year Review (AFCEE 2008a) and with concurrence from EPA, interviews were not conducted as part of this Five Year Review. It was agreed that the on-going, iterative interaction between AFCEC, the regulatory agencies, and the broader stakeholder group, for example through the MMRCT meeting process, provided sufficient opportunity for any and all stakeholders to communicate issues or concerns.

3.7 OVERVIEW OF THE SPEIM/LTM PROGRAM

AFCEC's SPEIM/LTM program was developed to monitor changes to the groundwater plumes and to ensure the effective operation of the AFCEC groundwater remediation systems at the MMR. These objectives are met through the routine monitoring of selected media (i.e., groundwater, surface water) within and outside the groundwater plume boundaries, at the treatment plants, and through groundwater flow and transport modeling. The data collected under the SPEIM/LTM program are continually assessed by a team of professional staff and the results of these assessments are presented to the regulatory agencies initially during periodic Technical Update meetings and then through technical memoranda or project note deliverables, if warranted, based on the results of the data evaluation or to address particular plume issues. Updates on the status of the remedial action at each plume are provided to a broader stakeholder group at MMRCT meetings.

In addition, AFCEC prepares annual SLRs for the groundwater plumes that are being addressed through active treatment under the SPEIM program. The purpose of these SLRs is to document the results of sampling activities conducted at each plume under the SPEIM program. The SLRs also include: (i) a summary of all major events and optimizations completed at the plume; (ii) O&M-related system performance information such as contaminant mass removal/air emissions, system flow rate summaries, and downtime summaries; and (iii) all relevant technical assessment documentation completed during the annual reporting period as attachments or by reference. For the groundwater sites where active treatment was not part of the remedy, remedial progress is assessed and the results are provided through the submittal of LTM project notes or letter reported. The SLRs and LTM deliverables are provided to the broad stakeholder group for each plume or site including Federal (EPA) and State (MassDEP, Massachusetts Department of Public Health [MassDPH]) regulatory agencies, town departments (such as the BOHs, Departments of Public Work, Water Departments, and/or Conservation Commissions), affected property owners, and other interested parties as applicable. The

SLRs and LTM deliverables are publically available in the IRP Administrative Record and copies are maintained at the local town libraries.

3.8 SUSTAINABILITY

In a world that is resource limited and increasingly aware of activities that could impact global climate, there is growing emphasis on designing and maintaining more sustainable, low-impact engineering solutions. This emphasis on sustainability extends to the remediation of soil and groundwater. AFCEC is committed to a more complete evaluation of sustainability metrics when considering and comparing the total impacts, benefits, and life-cycle costs of the environmental remediation decisions and actions made in support of the IRP at MMR.

Various private and public organizations have developed policies and guidance documents on the application of sustainable practices in remediation. These practices are driven by social, environmental, and economic pressures which constitute the "triple bottom line" of sustainability. Presidential Executive Orders 13423 (Bush 2007) and 13514 (Obama 2009) imposed specific goals to federal agencies regarding the incorporation of sustainable practices. The EPA clarified and enhanced those goals through a technology primer on green remediation (EPA 2008) and *Principles for Greener Cleanups* (EPA 2009). EPA Region 1 reiterated the principles described in EPA 2009 through a policy statement in 2010 which was updated in February 2012 (EPA 2012b).

As outlined in the EPA's Technology Innovation Program's CLU-IN website, the EPA is committed to developing and promoting innovative cleanup strategies that restore contaminated sites to productive use, reduce costs, and promote environmental stewardship, while ensuring that cleanups are protective of human health and the environment. In accordance with EPA's strategic plan for compliance and environmental stewardship, the Agency strives for cleanup programs that use natural resources and energy efficiently, reduce negative impacts on the environment, minimize pollution at its source, and reduce waste to the greatest extent possible. EPA supports the adoption of

green remediation as the practice of considering all environmental effects of cleanup actions and incorporating strategies to maximize the net environmental benefit.

Green remediation results in effective cleanups minimizing the environmental and energy "footprints" of site remediation and reuse. Sustainable practices emphasize the need to more closely evaluate core elements of a cleanup project:

- Energy requirements of the treatment system,
- Air emissions,
- Water requirements and associated impacts on water resources,
- Impacts on land and ecosystems,
- Material consumption and waste generation, and
- Long-term stewardship actions.

Starting in 2003, AFCEC has been promoting a strategy that fully encompasses environmental effects of cleanup actions when evaluating groundwater system operations and optimizations in order to more holistically address protectiveness. Since 2003 and prior to the development of the current green and sustainable guidance documents and approaches, AFCEC has been proactive in incorporating sustainability considerations into the SPEIM/LTM/O&M program at MMR. Examples of sustainability initiatives implemented by AFCEC at MMR include:

- Increasing use of green power through installation of a 1.5-megawatt on-site wind turbine in 2009.
- Construction of two additional 1.5-megawatt wind turbines in 2011 resulting in the AFCEC groundwater cleanup program being powered by 100 percent renewable energy.
- Switching to power suppliers that purchase renewable energy certificates and provide green power.
- Conducting energy audits and implementing energy conservation measures such as efficient lighting, occupancy sensors, and programmable thermostats; and enrollment in a demand response program.
- Performing remedial system optimization evaluations with the objective of accelerating aquifer restoration timeframe while reducing operational flow rates and

total treated volume. Initiatives include adjusting flow rates and installing packers at individual extraction wells and developing beneficial reinjection/infiltration strategies.

- Applying remedial process optimization to treatment processes including the assessment of alternative granular activated carbon (GAC) products with the goal of reducing the overall program costs and/or providing for a more sustainable treatment approach.
- Installing variable frequency drives which can eliminate booster pumps and downsize pump motors.
- Using AFCEC-owned and self-performed direct push drilling technology to reduce costs and waste generation and minimize impacts on the environment and community.
- Increasing use of biofuels and environmentally sensitive hydraulic oil in fleet vehicles.
- Improving the trophic health of a pond by using an innovative zero-valent iron geochemical barrier that passively removes phosphorus discharging into the pond.
- Reusing treated water for irrigation.
- Using passive/no-purge sampling techniques rather than techniques that require pumps, resulting in energy savings and less waste generation.

3.9 REFERENCES

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4.0 SOURCE AREAS REQUIRING FIVE-YEAR REVIEW

This section presents the source area sites for which a Five Year Review is required. Six sites (**Table 1-2**) require a Five Year Review because of one of the following conditions:

- additional investigative work has been completed during this Five Year Review period that indicates further evaluation and/or remedial actions are required (CS-10/FTA-2/PFSA);
- additional investigative work has been completed during this Five Year Review period that indicates the site does not meet UU/UE therefore institutional controls are required (SD-4); or
- landfills that have restricted use (LF-1, LF-2, LF-7).

After issuance of the last CERCLA Five Year Review (AFCEE 2008), AFCEC and the regulatory agencies have determined that the 1988 decision document for the CY-2 source area site was not fully executed and, therefore, no remedy has been established. As such, a five year review is not required for CY-2 and will not be subject to a protectiveness determination. However, for completeness, the recommendations from the last CERCLA Five Year Review and associated background information and site status for Coal Yard-2 are addressed in Section 4.2.

4.1 CS-10/FS-24 (UTES/BOMARC DETAILS C AND F)

The CS-10/FS-24 source area occupies approximately 52 acres at the eastern boundary of the MMR (**Figures 1-2** and **4-1**). Originally, the CS-10/FS-24 source area consisted of a number of buildings constructed as part of the BOMARC site by the USAF. Shelters utilized by the missile launcher systems along with a subsurface utility corridor connecting the shelters (utilidor system) were removed from the site in 2005. The site is currently used by the Massachusetts ARNG as the Unit Training Equipment Site (UTES) facility for maintenance and storage of vehicles. In addition, the CS-10/FS-24 source area was the primary source for the CS-10 groundwater plume discussed in Section 5.3.

4.1.1 Site Chronology

Pre-1956: CS-10/FS-24 consisted of a wooded area.

1958: Construction of the BOMARC missile site begins.

1960-1973: The USAF maintains approximately 56 BOMARC ground-to-air missile launcher systems in a state of operational readiness. The BOMARC facility was abandoned in 1973.

1978: The ARNG incorporated the abandoned missile facility into Camp Edwards UTES and began limited use of the abandoned buildings for equipment maintenance and storage. UTES personnel are responsible for maintaining 300 to 350 armored track and wheeled vehicles used for Camp Edwards ARNG training activities.

1985-1988: Records search and SI activities were completed (E.C. Jordan Co. 1986, 1989, and 1990).

1989-1990: RI activities were conducted at CS-10/FS-24 (ABB-ES 1992, AFCEE 1997).

1998-1999: A focused feasibility study (AFCEE 1998) and a ROD (AFCEE 1999) were completed.

2002-2005: The CS-10 Detail C soil vapor extraction (SVE) system operated from February 2002 through June 2005. The SVE system consisted of three extraction wells, eight monitoring/observation wells, and a vapor treatment system. The three extraction wells were shut down in March 2003, January 2004, and June 2005, respectively. The system was decommissioned in June 2005.

2003: An ESD was prepared addressing changes at CS-10/FS-24 source area Details A, B, and E (AFCEE 2003a).

2005: Shelters utilized by the BOMARC missile launcher systems along with a subsurface utility corridor connecting the shelters (utilidor system) were removed.

2011: An ESD was prepared addressing various changes to the remedy for the CS-10 source area details (AFCEE 2011). This ESD supports the UU/UE determinations for CS-10 Detail A, Detail B, Detail D, Detail E, Detail G, Detail H, and Detail I. CS-10 Detail C and Detail F did not meet UU/UE conditions.

4.1.2 Background

4.1.2.1 History of Contamination

The former BOMARC facility, now demolished, and UTES facility are considered the primary sources of historic contamination to soils in the source area and the CS-10 groundwater plume from 1960 to the early 1990s. Other sources of contamination are presumed to have contributed to the CS-10 groundwater plume as it traveled beneath the MMR (see Section 5.3).

Maintenance operations at CS-10/FS-24 involved the use of cleaning solvents (methylene chloride, 1,1,1-trichloroethane [1,1,1-TCA], trichloroethene [TCE], tetrachloroethene [PCE], and Freon). BOMARC fuels included Jet Propulsion-4 (JP-4), Aerozine-50, red fuming nitric acid, and hydrazine. Fuels used for power and heat generation included No. 2 fuel oil and diesel fuel. Several buildings had floor drains connected to dry wells, building sumps, oil interceptors, and other drainage structures; some of these drainage structures were connected to the site storm drain system, which discharges to either the

Eastern Storm Sewer Drainage Impoundment or the Southern Storm Sewer Outfall Drainage Ditch. The BOMARC facility was abandoned by the USAF in 1973. Activities at the UTES facility included the handling and use of motor oil, hydraulic fluid, battery electrolyte, PCE, PD-680 Safety Clean, paints, and paint removers (AFCEE 2008).

In 1985, during an investigation of the possible impact of UTES/BOMARC activities on local groundwater quality, several chlorinated organics were detected in the groundwater (E.C. Jordan Co. 1986). An SI conducted from 1986 to 1988 identified numerous contamination sources in the BOMARC area and detected contaminants in the soil (fuel- and oil-related polycyclic aromatic hydrocarbons [PAHs], pesticides, polychlorinated biphenyls [PCBs], and inorganics) and groundwater (halogenated solvents cis-1,2-dichloroethene, TCE, and PCE) (E.C. Jordan Co. 1989 and 1990). Based on the results of the SI, an RI was performed. An interim RI (ABB-ES 1992) and final RI (AFCEE 1997) conducted in 1989 and 1990 characterized potential sources of groundwater contamination, confirmed conceptual models, and delineated the extent of contaminant source areas (i.e., leaching pits, oil/water interceptors, residual soil). The CS-10/FS-24 source area was divided into nine details as described in Section 4.1.2.4.

4.1.2.2 Physical Characteristics, Land and Resource Use

The CS-10/FS-24 source area is located near the eastern boundary of the MMR to the west of Snake and Weeks ponds (**Figure 1-2**). Groundwater beneath the source area is at approximately 85 feet (ft) below grade and flows in a general southerly direction. The land in the area is currently used for the UTES operations. The area is abutted to the north, south, and west by woodland areas that are used by ARNG for training. Private residences are located to the east of CS-10/FS-24.

4.1.2.3 Initial Response

A summary of the initial responses is as follows:

Underground Storage Tank Removal: A leaking 25,000-gallon underground storage tank (UST) located at the northwest corner of Building 4606 at the BOMARC/UTES site was removed. Fewer than 500 gallons of No. 2 fuel oil were reportedly released from the

tank. This fuel spill site was designated Fuel Spill-24 (FS-24) (Detail G). Soil affected by the fuel spill was excavated to the maximum extent possible and removed from the site, and the excavation was backfilled with clean sand (AFCEE 2008).

Drainage Structure Removal Program: Sixteen drainage structures, associated piping, and surrounding soil were removed and two drainage structures were cleaned and filled in place with concrete at CS-10 as part of the Drainage Structure Removal Program (DSRP). In addition to the drainage structures, a total of 31,550 gallons of liquids were removed from the structures and 702 cubic yards of contaminated soil were removed (AFCEE 2008).

CS-10 Source Area Remedial Action: Approximately 250 cubic yards of contaminated soil were removed from the CS-10 Details A, B, E, and H and transported off site. An SVE system (**Figure 4-1**) was constructed and operated in the CS-10 source area (Detail C) from 2002 to 2005 and during that time the system removed approximately 5 pounds (lbs) of volatile organic compounds (VOCs) from the soil (AFCEE 2008).

4.1.2.4 Basis for Taking Action

The Final RI (AFCEE 1997) characterized potential sources of groundwater contamination, confirmed conceptual models, and delineated the extent of contaminant source areas (i.e., leaching pits, oil/water interceptors, residual soil). The CS-10/FS-24 source area was divided into nine discrete details as described below. **Figure 4-1** presents the locations of the CS-10/FS-24 details.

- Detail A consisted of surface soil contamination associated with an abandoned electrical switching station. Surface soil samples collected in the vicinity of the abandoned electrical switching station along the utilidor system were found to contain elevated concentrations of total petroleum hydrocarbons (TPH) and inorganics (arsenic, cadmium, chromium, copper, lead, vanadium, and zinc).
- Detail B consisted of surface soil contamination associated with operations at a former BOMARC maintenance shop. PAHs and TPH were detected in surface soils.
- Detail C consisted of subsurface soil contamination associated with a former 300 gallon JP-4 UST. PCE and TPH were detected in subsurface soils. Leaching of contaminants to groundwater was a concern for this detail.

- Detail D consisted of surface soil contamination associated with waste oil disposal activities. The disposal site is located in a clearing in the woods approximately 150 ft north of the BOMARC security fence. Lead, vanadium, methylene chloride, and TPH were detected at elevated concentrations in surface soil at this detail.
- Detail E consisted of surface soil and sediment contamination associated with the Southern Storm Sewer Outfall Drainage Ditch. One 24-inch-diameter storm sewer received runoff from southern portions of CS-10. In the past, effluent from the leaching wells and effluent from a waste oil interceptor also discharged at the Southern Storm Sewer Outfall. Surface soils contained pesticides, TPH, PCBs, PAHs, and inorganics (arsenic, chromium, copper, cyanide, lead, manganese (Mn), vanadium, and zinc).
- Detail F consisted of surface soil and sediment contamination associated with the Eastern Storm Sewer Outfall Drainage Impoundment. The drainage impoundment is located outside the UTES/BOMARC security fence northeast of the entrance from Greenway Road. Four storm water sewer outfalls located within the fenced UTES/BOMARC site discharge to this impoundment. In the past, effluent from the former Weapons Systems Electronics Shop's oil interceptor and from floor trench drains also discharged through this storm sewer system. PAHs, PCBs, pesticides, and several inorganics (aluminum, cadmium, chromium, copper, lead, Mn, vanadium, and zinc) were detected in soil and/or sediment at the Eastern Sewer Drainage Impoundment.
- Detail G, also known as FS-24, consisted of subsurface soil contamination associated with a former 25,000-gallon UST located in the center of the BOMARC site. Methylene chloride and TPH were detected in subsurface soils. Leaching of contaminants to groundwater was a concern for this detail.
- Detail H consisted of subsurface soil contamination associated with a former storage area that was located in the eastern portion of the BOMARC site. PCE and TPH were detected in subsurface soils. Leaching of contaminants to groundwater was a concern for this detail.
- Detail I consisted of surface and subsurface soil contamination associated with maintenance operations at Building 4601 (which remains). PCE, inorganics (arsenic, chromium, lead, vanadium) and bis-2-ethylhexyl phthalate were detected in soils.

As part of the RI, risk assessments for CS-10 Operable Units A & B were performed. CS-10A and CS-10B Operable Units consisted of the following details: A, B, C, D, G, H, and I. Results of the preliminary risk assessment (PRA) for soil indicated that calculated carcinogenic and noncarcinogenic risk for all human health exposure scenarios (i.e., current worker, current trespasser, and potential future resident) did not exceed EPA risk management guidelines (i.e., risk range of $1x10^{-4}$ to $1x10^{-6}$ for carcinogens and hazard index (HI) of less than 1.0 for non-carcinogens).

The MassDEP's criteria of Excess Lifetime Cancer Risk of one in one hundred thousand (i.e., $1x10^{-5}$) was slightly exceeded for potential future exposure to soil by child residents (age 1 to 6 years). The cumulative cancer risk based on maximum concentrations detected in soil was $1.82x10^{-5}$.

A human health PRA was also completed for the Southern Storm Sewer Outfall Drainage Ditch Area (i.e., Detail E). Results of the PRA indicated that calculated carcinogenic and noncarcinogenic risk for all human health exposure scenarios (i.e., current worker, current trespasser, and potential future resident) did not exceed EPA risk management guidelines for both carcinogens and non-carcinogens.

The MassDEP's criteria of Excess Lifetime Cancer Risk of one in one hundred thousand (i.e., $1x10^{-5}$) was slightly exceeded for the following exposure scenarios: future child resident exposed to exposure point mean concentrations ($1.04x10^{-5}$) and maximum concentrations ($7.12x10^{-5}$), and future adult resident exposed to maximum concentrations ($3.05x10^{-5}$).

4.1.3 Remedial Actions

The final remedy for CS-10/FS-24 was presented in the *Record of Decision Area of Contamination CS-10/FS-24 Source Areas* which was signed on 16 August 1999. The RAOs established for CS-10/FS-24 were:

- To minimize adverse impacts to ecological receptors from source area contaminated soil, sediment, and surface water estimated to exceed a hazard index of 1 or exceed soil target cleanup levels (STCLs) based on ecological risk.
- To provide a source control alternative that minimized future migration of contaminants in soil/sediments to the underlying aquifer and to off-site locations as determined by exceedances of STCLs based on leaching.
- To the extent feasible, to reduce the concentration of the inorganic COCs in soil/sediments to achieve or approach STCLs based on background.

4.1.3.1 Remedy Selection and Implementation

The following subsections provide a summary of the remedy selected in the ROD, changes to the selected remedy through the issuance of ESDs, and an overview of the remedial actions completed at each of the CS-10/FS-24 details.

CS-10/FS-24 ROD: The selected remedy for CS-10/FS-24 presented in the ROD was Alternative 3: Excavation, On-site Asphalt Batching and Off-site Disposal/In Situ Thermally Enhanced SVE/Environmental Monitoring (AFCEE 1999). The major components of this alternative included: (1) the removal of contaminated surface water from the Eastern Storm Sewer Outfall Drainage Impoundment at Detail F; (2) excavation and dewatering (if necessary) and temporary on-site stockpiling of an estimated 3,400 cubic yards of contaminated surface soil and sediments from seven of the nine source areas (Details A through F and I); (3) installation of an in-situ, thermally-enhanced SVE and vapor collection system at Detail C; (4) implementation of a confirmatory sampling plan at Details G and H; and (5) implementation of institutional and engineering controls (e.g., site access restrictions) to limit exposure to site-related contaminants.

2003 Explanation of Significant Differences: The *Explanation of Significant Differences for Areas of Contamination CS-10 (A, B & E); CS-16/CS-17; FS-9; SD-2/FS-6/FS-8; SD-3/ FTA-3/CY-4* finalized in January 2003 (AFCEE 2003a) was prepared to document changes to the selected remedy for several sites including Details A, B, and E of the CS-10/FS-24 ROD. Three changes were made to the selected remedy presented in the CS-10/FS-24 ROD: (1) establishment of remedial action levels (RALs) for certain inorganic chemicals, PCBs, and petroleum hydrocarbons at Details A, B, and E; (2) removal of the asphalt-batching component from the selected remedy of Details A and B; and (3) the expansion of offsite disposal options to include RCRA Subtitle D facilities.

CS-10 Details A, B, E, and H Soil Excavation and Disposal: AFCEE conducted remedial action activities in 2001 at CS-10/FS-24 Details A, B, E, and H. Removal activities and

results of confirmatory sampling were documented in a Remedial Action Report (RAR) (AFCEE 2003b). Approximately 250 cubic yards of contaminated soil were removed from the CS-10 Details A, B, E, and H. Confirmatory sampling results indicated that the contaminant concentrations in soil were below the RALs. Excavated soil was transported to a central bulking facility located on the MMR. Soil from CS-10/FS-24 was combined with soil from other sites excavated under AFCEE's Source Area Remedial Action Program. Composite sampling of the consolidated soil stockpiles determined that the consolidated soil was considered non-hazardous and suitable for reuse as daily cover at a RCRA Subtitle D Landfill. Soil from CS-10/FS-24 was disposed of at the Taunton Landfill in Massachusetts. Disposal activities were performed in compliance with the MassDEP *Reuse and Disposal of Contaminated Soil at Massachusetts Landfills Policy #COMM-97-001* (MassDEP 1997).

<u>CS-10 Details D, G, and I Confirmatory Sampling</u>: Analytical results from the pre-design and/or delineation sampling at CS-10 Details D, G, and I indicated that all COC concentrations were below RALs and consequently no soil removal was needed. A vadose zone characterization report employing VLEACH, an EPA-approved leaching model, was completed to address residual PCE contamination in subsurface vadose zone soils at CS-10 Details C, H, and I. The report concluded that the PCE contamination in vadose zone soils would not impact groundwater (AFCEE 2002 and 2005).

<u>CS-10 Detail C UST Removal</u>: In 2000, AFCEE removed a UST which was designated as part of Detail C. The 300-gallon UST was reportedly used for the storage of jet fuel; however, the contents reportedly contained a PCE/water mixture. The tank was pumped out and the contents were disposed offsite as a RCRA hazardous listed waste. The tank was removed and sent offsite to a scrap yard. The UST removal was documented in the CS-10/FS-24 RAR (AFCEE 2003b). The UST removal was not part of the original remedy presented in the ROD but was addressed in the *Explanation of Significant Differences Areas of Contamination CS-10/FS-24, FS-1, and FS-9* (AFCEE 2011) described later in this section.

CS-10 Detail C SVE System: A pre-remedial action delineation program was performed to identify the boundaries of PCE and petroleum hydrocarbon contamination and to optimize placement of extraction wells associated with an SVE system at Detail C. PCE delineation results were compared to the ROD cleanup level of 10 micrograms per kilogram (µg/kg). Sampling was conducted in November 2000, December 2000, and December 2001 to determine the lateral and vertical extent of the Detail C PCE contamination. Fourteen locations were sampled prior to startup of the SVE system. The contamination was found to be located between 4 and 45 ft below ground surface (bgs) within the vadose zone. The CS-10 Detail C SVE system operated from February 2002 through June 2005. The SVE system consisted of three extraction wells, eight monitoring/observation wells, and a vapor treatment system (**Figure 4-1**). The hot air injection wells that were a component of the remedy identified in the ROD were not installed; this change was addressed in the 2011 ESD (AFCEE 2011). The vapor treatment system included two 300-lb GAC vessels, a moisture tank, and a thermal oxidizer. The thermal oxidizer was shut down in October 2003. The three extraction wells were shut down in March 2003, January 2004, and June 2005, respectively. The system was decommissioned in June 2005. A vadose zone characterization report employing VLEACH, an EPA-approved leaching model, was completed to address residual PCE contamination in subsurface vadose zone soils at CS-10 Detail C. The report concluded that the PCE contamination in vadose zone soils would not impact groundwater (AFCEE 2005). An RAR summarizing the operation of the SVE system at Detail C was finalized in September 2009 (AFCEE 2009).

CS-10 Detail F Revised Screening Level Ecological Risk Assessment: The results of this Screening Level Ecological Risk Assessment (ERA) suggested that wetland receptors (e.g., plants and invertebrates), aquatic and benthic receptors (e.g., invertebrates) may potentially be at risk from exposure to several inorganic compounds in hydric soil/sediment and surface water in CS-10 Detail F (Eastern Storm Sewer Outfall Drainage Impoundment). However, it was determined that little to no significant potential risks to vertebrate wildlife was likely from exposure to contaminants of potential concern (COPCs) in hydric soil/sediment (AFCEE 2004a).

CS-10 Detail F Ecological Risk Assessment Addendum: The ERA Addendum was prepared to evaluate the potential ecological risks to lower trophic level receptors through the benchmark screening of additional surface water and hydric soil/sediment samples and the use of site-specific laboratory toxicity testing. The results of this ERA Addendum indicated that, although there were elevated levels of several inorganic and organic chemicals present in surface water, sediments and hydric soils in the wetland portion of CS-10 Detail F, these levels were not likely to have a significant negative impact on the wetland plant and invertebrate communities (AFCEE 2004b).

CS-10 Source Area Investigation Results: A source area groundwater and subsurface soil investigation was completed at the CS-10 source area in 2005 in the area immediately south of Building 4601 (AFCEE 2006). The primary objectives of this investigation were to determine:

- The extent of groundwater contamination in the source area;
- If contamination extended into the vadose zone and represented a continuing source for groundwater contamination; and
- If groundwater contamination detected in the source area represented a continuous plume from the source area to a downgradient CS-10 groundwater extraction well.

These objectives were addressed through the sampling of 27 existing monitoring wells, the completion of four groundwater vertical profile borings, and subsurface soil sampling. All groundwater and soil samples were analyzed for VOCs. For additional information on the status of CS-10 groundwater including near the CS-10/FS-24 source area, refer to Section 5.3. PCE was detected in two samples at concentrations of 19 μg/kg (at 12 ft bgs) and 0.36 μg/kg (at 86 ft bgs). These concentrations are well below the Massachusetts Contingency Plan (MCP) S-1/GW-1 Standard of 1,000 μg/kg for PCE. PCE was not detected in any of the other soil samples collected and TCE was not detected in any of the soil samples collected. Other VOCs detected include toluene, ethylbenzene, and total xylenes. These fuel-related VOCs were detected at very low concentrations (less than 10 μg/kg) and well below the MCP S-1/GW-1 standards for these compounds (AFCEE 2006). It was concluded that the PCE detections in vadose

zone soils did not represent a potential continuing source for the CS-10 groundwater plume.

2011 Explanation of Significant Differences: The *Explanation of Significant Differences Areas of Contamination CS-10/FS-24, FS-1, and FS-9* (AFCEE 2011) documents additional changes to the selected remedy presented in the CS-10/FS-24 Source Area ROD (AFCEE 1999) as follows:

1) Removal of site access control and allow property (0-15 ft bgs) for residential land use designated as Details A, B, D, E, G, H, and I as a result of comparison of data collected during the RI, remedial action delineation data, and/or remedial action confirmation data with May 2010 EPA residential risk-based Regional Screening Levels (RSLs) and MassDEP MCP S-1/GW-1 standards;

2) Revise the existing RALs for C_{19}-C_{36} aliphatic hydrocarbons and C_{11}-C_{22} aromatic hydrocarbons for Detail A, Detail B, Detail C, Detail G, and Detail H by incorporating MassDEP S-1/GW-1 standards promulgated in 2008;

3) Removal of the hot air injection wells as a component to the CS-10 Detail C treatment system and the addition of a thermal oxidizer to the CS-10 Detail C treatment system;

4) Removal of the UST from CS-10 Detail C;

5) No remedial action required for CS-10 Detail F as a result of the findings of the ecological risk evaluation using new data performed in 2004; and

6) SVE system shutdown for CS-10 Detail C, limited remedial action for soil at CS-10 Detail H, and no further action for subsurface soil for CS-10 Detail I as a result of performing an impact to groundwater analysis for PCE in the unsaturated zone using the vadose zone modeling software (VLEACH).

4.1.3.2 Remedy Operation &Maintenance

No ongoing O&M activities are being conducted at the CS-10/FS-24 source area.

4.1.4 Progress Since Last Five Year Review

Per the EPA guidance document (EPA 2001), this section summarizes the progress made on the specific recommendations and follow-up actions presented in the prior third CERCLA Five Year Review (AFCEE 2008). For the CS-10/FS-24 source area, the recommendations and follow-up actions were:

1) Prepare and issue an RAR and ESD for Details C and F.

Progress since the last Five Year Review against this recommendation is as follows:

1) As identified in Section 4.1.3.1, both an RAR summarizing the operations of the former SVE system at Detail C (AFCEE 2009) and an ESD (AFCEE 2011) identifying all details other than C and F for removal of access controls and eligible for residential use were completed. The ESD is the basis for a UU/UE determination for all details other than Details C and F and thus they will not be addressed in future Five Year Reviews.

4.1.5 Five Year Review Process

4.1.5.1 Data Review

Additional soil characterization data were collected at Detail C between 05 July 2012 and 10 July 2012 to determine whether residual petroleum hydrocarbon concentrations remain in vadose zone soils. Soil samples were collected at three soil boring locations (03BH1000, 03BH1001, and 03BH1002 shown on **Figure 4-1**) at three depth intervals within the vadose zone (approximately 7-10 ft bgs, 10-13 ft bgs, and 13-16 ft bgs). The soil samples were submitted for MassDEP extractable petroleum hydrocarbon/volatile petroleum hydrocarbon (EPH/VPH) analysis. All EPH/VPH concentrations were below MCP Method 1 S-1/GW-1 standards, with the exception of one sample, 03BH1000,

collected at 13-16 ft bgs which exceeded the S-1/GW-1 standard for the following two hydrocarbon fractions: C_9-C_{18} aliphatic hydrocarbons and C_9-C_{10} aromatic hydrocarbons. A summary of the EPH/VPH results are included in **Table 4-1**.

4.1.5.2 Site Inspections

An SI was completed for CS-10/FS-24 on 19 June 2013. The SI form is included in **Appendix B**. Since the remedial actions conducted at CS-10/FS-24 are complete and no actions require ongoing O&M and no formal LUCs are currently in place, the focus of the SI was to assess general site conditions and to determine whether the land use assumptions are still valid and do not affect protectiveness. Based on the SI, land use at the site remains consistent with the assumptions used in the risk assessment and no concerns regarding protectiveness were identified.

4.1.5.3 Interviews

Refer to Section 3.6.

4.1.6 Technical Assessment

The technical assessment component of the Five Year Review consists of evaluating the protectiveness of the remedy. The technical assessment is based on EPA guidance provided in Section 4.0 of the Comprehensive Five Year Review Guidance (EPA 2001).

4.1.6.1 Question A: Is the remedy functioning as intended by the decision document?

For CS-10 Details A, B, D, E, G, H, and I; the remedial actions have been completed and are functioning as intended by the ROD as modified by the ESD. An ESD (AFCEE 2011) has been prepared for these details and the ESD is the basis for a UU/UE determination for these details and thus they will not be addressed in future Five Year Reviews.

For CS-10 Detail C, the remedial action has been completed, an RAR has been prepared (AFCEE 2009), and the remedy is functioning as intended under current land use. However, residual EPH/VPH concentrations remain in vadose zone soils (Section 4.1.5.1) and these data should be further assessed to determine whether UU/UE closure can be reasonably achieved.

For CS-10 Detail F, no further remedial action is required based on the ecological risk analysis and the remedy is functioning as intended under current land use. However, residual PAH, PCB, and inorganic concentrations remain in soils/sediments and these data should be further assessed to determine whether UU/UE closure can be reasonably achieved.

4.1.6.2 Question B: Are the exposure assumptions, toxicity data, cleanup level, and RAOs used at the time of remedy selection (current) still valid?

Changes in Standards and To-Be Considered: MassDEP has re-evaluated S-1/GW-1 soil standards for EPH/VPH since the last Five Year Review. The new S-1/GW-1 soil standards became effective on February 14, 2008 (see 310 Code of Massachusetts Regulations [CMR] 40.0975(6) (a)). The new MassDEP S-1/GW-1 soil standards do not change the protectiveness of the implemented remedy.

Changes in Exposure Pathways: There have been no changes in the physical conditions and land use of the site that would affect the protectiveness of the remedy. However, the VI pathway should be assessed at Details C and F using existing site characterization data since this exposure pathway was not evaluated in the baseline risk assessment.

Changes in Toxicity and Other Contaminant Characteristics: MassDEP has re-evaluated S-1/GW-1 standards for EPH/VPH since the last Five Year Review. The MassDEP S-1/GW-1 standards are based on unrestricted use and take into consideration dermal exposure, ingestion exposure, and potential impacts to groundwater. The new MassDEP S-1/GW-1 soil standards do not change the protectiveness of the implemented remedy.

Changes in Risk Assessment Methods: There were no changes in risk assessment methodology.

Review of RAOs: RAOs are appropriate.

4.1.6.3 Question C: Has any other information come to light that could call into question the protectiveness of the remedy?

There is no other information at this time that calls into question the short-term protectiveness of the remedy based on current land use. This IRP site is located within installation boundaries and exposure pathways for humans are currently controlled or mitigated by the Department of Defense (DoD) and/or USCG land use and management practices. The no further action is also protective of ecological receptors.

4.1.7 Issues, Recommendations, and Follow-Up Actions

Complete a reassessment of Detail C EPH/VPH data and Detail F PAH, PCB, inorganic data and pursue UU/UE closure; however, if this cannot be achieved, then pursue a LUC which would be documented in an ESD.

The VI exposure pathway should be assessed at Detail C and Detail F. It is recommended that these sites be screened utilizing applicable EPA guidance including the *OSWER Guidance for Assessing and Mitigating the Vapor Intrusion Pathway from Subsurface Sources to Indoor Air* and *Guidance for Addressing Petroleum Vapor at Leaking Underground Storage Tanks Sites,* which have both been released for external review in 2013 and are due to be released final by the end of 2013.

4.1.8 Protectiveness Statement

The remedies for CS-10/FS-24 source area Details A, B, D, E, G, H, and I are protective of human health and the environment. The remedies for CS-10/FS-24 source area Details C and F are protective of human health and the environment in the short-term under the current land use scenario. However, for the remedies to be protective in the long-term it is recommended that existing site characterization data be

re-evaluated to determine if UU/UE conditions have been met; if UU/UE closure cannot be supported for Details C and/or F, then either (i) conduct additional cleanup activities to levels that allow UU/UE; or (ii) issue a decision document implementing enforceable LUCs preventing uses for which the site may still pose an unacceptable risk under future uses that would ensure long-term protectiveness.

4.1.9 References

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4.2 COAL YARD (CY) -2

CY-2 had been addressed in previous five year reviews based on the assumption that the CY-2 Decision Document (E.C. Jordan Co. 1988) issued in 1988 was valid. After issuance of the third CERCLA Five Year Review (AFCEE 2008), AFCEC and the regulatory agencies have determined that the 1988 decision document was not fully executed and, therefore, no remedy has been established. As such, CY-2 will not be subject to a protectiveness determination in this Five Year Review.

For completeness, the recommendations from the third CERCLA Five Year Review for CY-2 and associated background information and site status will be addressed herein.

CY-2 is a former USAF and ANG coal storage area used from 1957 to 1984 (E.C. Jordan Co. 1989). CY-2 is located less than 1,000 ft from the southern MMR boundary at the corner of Kittredge Road and Generals Boulevard (**Figures 1-2** and **4-2**). CY-2 is now within the property of the Upper Cape Regional Transfer Station (UCRTS), a municipal waste truck-to-rail transfer station, which is operated under an inter-municipal agreement between the towns of Bourne, Falmouth, Mashpee, and Sandwich. A Board of Managers was established through the agreement with representatives from all four towns and a representative from the 102nd ANG to provide oversight of the UCRTS. The transfer station was built and opened in the area of the CY-2 site in 1989 and utilizes the existing railroad spur used for coal delivery to the MMR prior to 1984.

Most of the coal stockpiled at CY-2 from 1957 to 1984 was placed on a bituminous paved pad. However, some coal was placed on the ground surface north of the paved pad. Stormwater runoff from the site was channeled into a storm drain at the northwestern corner of the pad, or directed off the southern edge into an outfall pipe that leads to a natural northwest-southeast trending drainage swale that is located at the south-eastern section of the site (**Figure 4-2**).

4.2.1 Progress Since Last Five Year Review

This section summarizes the progress made on the specific recommendations and follow-up actions presented in the prior third CERCLA Five Year Review (AFCEE 2008). For CY-2, the recommendations and follow-up actions were:

1) EPA needs to review the decision document.
2) Conduct a reassessment of site data and current standards to determine if, based on future residential exposure, an unacceptable risk remains. In some cases, this may lead to the need to collect additional samples and/or conduct a risk assessment based on future residential exposure (using up-to-date toxicity data and exposure pathways). If this reassessment indicates that the site may still pose an unacceptable risk, then either (1) conduct additional cleanup to levels that allow for UU/UE, or (2) issue a decision document implementing enforceable institutional controls preventing uses for which the site may still pose an unacceptable risk.

Progress since the last Five Year Review against these recommendations is as follows:

1) EPA reviewed the CY-2 decision document and noted that data was not available to make a determination regarding closure.

2) A reassessment of CY-2 site data indicated that a soil removal action should be completed due the presence of arsenic in soil above the MCP Method 1 S-1/GW-1 standard of 20 milligrams per kilogram (mg/kg) if a UU/UE site closure is to be achieved.

4.2.2 Site Status

2009-2010: To assess whether the CY-2 site could achieve UU/UE site closure, further soil sampling was conducted to evaluate the extent of coal deposition and associated arsenic in soil near the southeastern edge of the paved pad. The volume of soil containing arsenic exceeding the MCP Method 1 S-1/GW-1 standard of 20 mg/kg was determined to be approximately 110 cubic yards (AFCEE 2012).

2011-2012: Additional soil borings were advanced to confirm horizontal and vertical limits of arsenic contamination in soil exceeding 20 mg/kg in the southeast stormwater outfall area. The study determined that coal particulates in soil as free coal and a coal/soil mixture were the source of the elevated arsenic concentrations, particularly in an area downgradient of the stormwater outfall (AFCEE 2012). A soil/coal removal action followed and 542 tons of soil (approximately 318 cubic yards) were removed. The upgradient (i.e., the northern and western) boundaries of the soil removal area met the cleanup goal of 20 mg/kg for arsenic. The MCP Method 1 S-1/GW-1 standard of 20 mg/kg was not achieved at the southern and eastern excavation limits during this removal work. AFCEC plans to return to the site after preparing an Engineering Evaluation/Cost Assessment (EE/CA). The EE/CA will establish RAOs, identify ARARs, evaluate cost-effective removal alternatives, and recommend a preferred removal alternative. The EE/CA will present the soil/coal removal work conducted to date as background, and the remaining work necessary to complete a non-time-critical removal action for CY-2. The EE/CA would support the preparation of an Action Memorandum.

4.2.3 References

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4.3 LANDFILL-1 (LF-1) SOURCE AREA

The LF-1 source area is located in the southern portion of MMR and is bounded by Turpentine Road to the east, Frank Perkins Road to the west, Herbert Road to the north, and Connery Avenue to the south (**Figures 1-2** and **4-3**). The LF-1 source area, which occupies approximately 100 acres of open to heavily wooded terrain, operated between 1941 and 1993 as the primary solid waste disposal facility at MMR (AFCEE 2012b).

4.3.1 Site Chronology

1983: A records search identified the landfill as a potential source for the VOCs detected in June 1979 in a base water supply well (the G well) located approximately 6,000 ft downgradient of the landfill (ANG 1983).

1985 – 1996: Numerous investigations (ANG 1985, 1991, and 1992b; and E.C. Jordan 1988, 1990a, 1990b) were conducted which culminated in an RI report (AFCEE 1996).

1993: The interim ROD for the LF-1 landfill (ANG 1993c) was completed.

1995 to 1996: Closure activities at the landfill, including capping three cells and instituting post-closure monitoring (PCM), were completed in December 1995. Landfill caps on the three most recently used cells (1970, Post-1970, and Kettle Hole) were constructed because these cells were the apparent sources of groundwater contamination (AFCEE 2012b).

1997 to Present: PCM and maintenance of the cover system is ongoing and monitoring of landfill gas and groundwater quality is conducted. Since 2005, the PCM activities have been documented in the annual LF-1 SLRs (AFCEC 2013b; AFCEE 2012c, 2011, 2010, 2009, 2008b, 2007b, 2006b); between 2000 and 2005, these activities were documented in annual LF-1 SPEIM reports (AFCEE 2005, 2004, 2003, 2002, and 2001); and prior to 2000, these activities were documented in PCM reports (AFCEE 2000, 1999, and 1998).

2006-2007: Preparation of the feasibility study (AFCEE 2006a) and ROD (AFCEE 2007a).

2012: Update to LF-1 PCM Plan (AFCEE 2012b).

2013: Submittal of an ESD applying the LUCs documented in the 2007 ROD to the Northwest Operable Unit (NWOU) (AFCEC 2013a).

4.3.2 Background

4.3.2.1 History of Contamination

The LF-1 source area occupies approximately 100 acres of open to heavily wooded terrain and began operating in 1941 as the primary solid waste disposal facility at MMR. From the late 1940s until 1984, unregulated disposal activities were conducted at the site. From 1984 to 1993, regulated disposal activities were conducted by the NGB at the LF-1 landfill as a component of the MMR Hazardous Waste Management Plan. Disposal at the landfill occurred in six areas consisting of five distinct cells and a natural kettle hole. The cells are designated by the years representing the approximate end date of waste disposal activities. The six disposal areas include the 1947, 1951, and 1957 cells, referred to as NWOU, which occupy approximately 40 acres of the total LF-1 landfill area; and the 1970 and Post-1970 cells and the Kettle Hole, which occupy approximately 50 acres. The remaining 10 acres comprise the space between and surrounding the cells. The thickness of waste burial has not been accurately determined, but is estimated to be about 20 ft thick for the 1970 and Post-1970 cells; while the thickness of waste in the Kettle Hole is unknown (E.C. Jordan Co. 1988 and 1990b). Approximately 100 additional acres were used in and around the site for construction soil material borrow pits, access roads, staging areas, and cross-gradient or downgradient surface water recharge areas (i.e., retention/detention basins).

Accurate documentation of the wastes disposed of at the LF-1 landfill does not exist. The wastes are believed to include general refuse, fuel tank sludge, herbicides, solvents, transformer oils, fire extinguisher fluids, blank small arms ammunition, paints, paint

thinners, batteries, dichlorodiphenyltrichloroethane (DDT) powder, hospital wastes, municipal sewage sludge, coal ash, and possibly live ordnance (AFCEE 2012b).

4.3.2.2 Physical Characteristics, Land and Resource Use

The LF-1 source area is currently maintained as a controlled area. This use is not anticipated to change over time. The LF-1 cover system is composed of a low permeability cap built on top of the three cells, an associated cover drainage system, and 70 passive gas vents designed to release gas from the interior of the landfill and minimize the potential for lateral gas migration. Gas probes are located around the perimeter of the capped cells and NWOU to monitor subsurface vapor. A perimeter fence exists around the entire landfill (capped cells and NWOU) which controls access. The maximum and minimum ground surface elevations within the fenced area are 166 ft msl and 98 ft msl, respectively. LUCs are in place to protect human health by limiting exposure to the source area material and by preventing intrusive work in the area.

4.3.2.3 Initial Response

An initial SI of the landfill was conducted (ANG 1985) and indicated there was minor evidence of landfill-derived leachate based on the presence of VOCs detected during monitoring well installation and sampling. Magnetic anomalies and the disposal boundaries were delineated through magnetometer and radar surveys of the landfill (E.C. Jordan 1990b). Soil gas data indicated that waste buried in the landfill emitted a wide variety of VOCs and that landfill gases related to the degradation of organic material (including methane) were being released to the atmosphere (E.C. Jordan 1990b). These investigations confirmed that contamination leaching from the LF-1 landfill was contributing to groundwater contamination.

4.3.2.4 Basis for Taking Action

The basic for taking action at the LF-1 source area is described in the following sections:

Interim Remedial Investigation: An interim RI was performed from 1987-1989 to further quantify the impact to groundwater downgradient of each landfill cell, to estimate the potential for each cell to be a continuing source of groundwater contamination, and to develop an initial CSM for the source area and associated groundwater plume. A risk assessment of the landfill (all six disposal areas) indicated that there was a potential for human health risks as a result of exposure to source area groundwater and that remedial action should be performed at the landfill to reduce contaminants leaching to groundwater (ANG 1992a). Groundwater data collected during 1989-1990 (ANG 1993a) indicated that significant contamination was not emanating from the older NWOU cells (1947, 1951, and 1957). An environmental justification report indicated that the NWOU was not a source of contamination and that it did not pose a public health risk or environmental hazard (ANG 1991). Hence, recommendations were made for no additional action (i.e., landfill cover) at the NWOU.

Remedial Investigation: From 1992 to 1994, the LF-1 RI was conducted and was intended to complete the characterization of the extent of subsurface contamination by defining the downgradient (horizontal and vertical) extent of the chlorinated solvent plume, and evaluating the stratigraphy and geology of the region (AFCEE 1996).

Focused Feasibility Study: A focused feasibility study (ANG 1992a) and final decision documents (ANG 1993b) addressed remedial objectives, remedial alternatives, alternatives analysis, and a detailed remedial design for the LF-1 source area. The design for contaminant source control was based on an interim remedial strategy to reduce contaminant leaching, limit migration of liquids through the landfill cells, and maintain compatibility with final remedial measures (ANG 1993c).

Feasibility Study: An feasibility study was completed in 2006 (AFCEE 2006a) to identify remedial alternatives for LF-1. Nineteen alternatives were evaluated. As part of

the feasibility study, a risk assessment was performed for groundwater and surface water (Buzzards Bay). Soil exposure pathways for humans and ecological receptors at the source area were not evaluated due to the cap and fence already installed at the landfill (interim remedial action described in Section 4.3.3.1).

4.3.3 Remedial Actions

The final remedy for the LF-1 source area was determined in the *Final Record of Decision for the LF-1 Source Area and Groundwater* (AFCEE 2007a) which was signed on 28 September 2007.

The RAOs for the LF-1 source area as presented in the ROD are as follows:

- Prevent the leaching from the source area of landfill contamination that would cause groundwater downgradient from the landfill to be unusable.
- Prevent risks to human health and the environment (if any) posed by the landfill.

4.3.3.1 Remedy Selection and Implementation

Interim Record of Decision: In 1993, EPA approved and MassDEP concurred with the *Record of Decision Interim Remedial Action, Main Base Landfill (AOC LF-1) Source Area Operable Unit* (ANG 1993c). The interim remedial plan, referred to as the preferred alternative, addressed LF-1 source control and recommended a method of minimizing further contamination from occurring using containment options evaluated during the focused feasibility study.

The interim remedial action for the landfill (ANG 1993c) consisted of the following actions:

1. Leaving NWOU wastes in place beneath the existing soil and vegetative cover and installing downgradient groundwater monitoring wells to assess any impacts from the older cells and to determine if the interim remedial action is an appropriate long-term remedial action.

2. Construction of a landfill cover system over the 1970 Cell, Post-1970 Cell, and the Kettle Hole.

3. Preparation of a PCM Plan for the 1970 Cell, Post-1970 Cell, and Kettle Hole.

<u>Final Record of Decision</u>: A final remedy for the 1970 Cell, Post-1970 Cell, and Kettle Hole was selected and documented in the September 2007 ROD (AFCEE 2007a). The NWOU (the 1947, 1951, and 1957 cells) was not included in this decision document.

The remedy for the LF-1 source area (the 1970-Cell, Post-1970 Cell, and Kettle Hole) provides for continued monitoring and maintenance of the existing landfill cover system. The objective of the remedy is to maintain the integrity of the landfill cover system to prevent leaching of contamination that would cause downgradient groundwater to be unusable and implement LUCs to prevent exposure to landfill waste.

Closure activities at the landfill, including capping three cells (1970, Post-1970, and Kettle Hole) and instituting PCM, were completed in December 1995 (AFCEE 2007a). The primary purpose of the landfill cover and associated drainage structures was to minimize the amount of precipitation that infiltrates the landfill and produces leachate that drains into the aquifer. It is expected that with a properly functioning cover, landfill drainage will become negligible once moisture in excess of the waste's field capacity has drained. The LF-1 cover system is composed of low permeability caps constructed over the three cells, an associated drainage system, and 70 passive gas vents designed to release gas from the interior of the landfill. Gas probes are located around the perimeter of the caps to monitor subsurface vapor. A perimeter fence was already in place around the entire landfill (capped cells and NWOU) at the time the cap was installed in 1995.

<u>Explanation of Significant Differences</u>: The NWOU was not included in the LF-1 ROD due to EPA concerns regarding surface soil contamination related to former Gun Positions (Old GP-2 and Old GP-3) that were used on the NWOU after the landfill cells were closed. The IAGWSP has addressed EPA's concerns regarding the NWOU surface soil contamination, allowing a decision document to be completed for the NWOU. An

ESD has been prepared that extends the applicable LUCs for the capped portion of the LF-1 landfill to the NWOU (AFCEC 2013a).

4.3.3.2 Remedy Operations & Maintenance

The Post-Closure Plan for Main Base Landfill (ANG 1993a), outlined the following actions:

1. PCM and maintenance of the cover system is to be conducted for a minimum of 30 years after the completion of cap construction. To verify that the cap maintains its structural integrity, it is inspected for animal burrows, erosion rills, settlement depressions, intrusive vegetation, seeps, and sedimentation in ditches and culverts. Post-closure maintenance is performed any time a loss of integrity is noticed; landfill surveys are performed regularly.

2. Landfill gas and groundwater quality at the landfill are to be monitored as appropriate. The landfill interim remedial action will allow time to further evaluate the environmental impact of the 1947, 1951, and 1957 cells on groundwater quality.

3. The performance evaluation of the interim remedial action occurs regularly.

In 1996, the EPA and MassDEP approved the closure report for the landfill site (ANG 1996), thus initiating the LTM program as defined in the Post-Closure Plan. Ongoing PCM activities were eventually combined with the SPEIM program for the interim (now final) groundwater remedial action. These activities include sampling groundwater monitoring wells, screening of landfill gas at 12 gas probes surrounding the perimeter of the LF-1 cover system, SIs, settlement monitoring, periodic maintenance of the cover system (i.e., mowing, repairing animal burrow holes, cleaning out drainage swales, etc.), and LUCs (i.e., ensuring perimeter fence is functional, gates are locked and appropriate signage is maintained). The post-closure activities conducted during this Five Year Review period are documented in several annual summary letter reports (AFCEC 2013b; AFCEE 2012c, 2011, 2010, 2009, 2008b).

4.3.4 Progress Since Last Five Year Review

Per the EPA guidance document (EPA 2001), this section summarizes the progress made on the specific recommendations and follow-up actions presented in the prior third CERCLA Five Year Review (AFCEE 2008a). For the LF-1 source area, the recommendations and follow-up actions were:

1) Continue LTM and landfill cap O&M activities as required by the final ROD.

2) The Air Force, Army, EPA, and MassDEP should develop a plan to resolve the GP issue on the NWOU with the ultimate objective of modifying the LF-1 remedy decision to include the NWOU cells.

Progress since the last Five Year Review against these recommendations is as follows:

1) As discussed in Section 4.3.3.2, landfill cap operation and maintenance activities have been performed annually as required by the ROD. In addition, the Post Closure Plan was updated in 2011 presenting the most current site information, monitoring program, and landfill cap operation and maintenance requirements (AFCEE 2012b).

2) The NWOU was excluded from the LF-1 ROD due to EPA concerns regarding surface soil contamination related to former GPs (Old GP-2 and Old GP-3) that were used on the NWOU after the landfill cells were closed. Soil sampling conducted at Old GP-2 by the Army under the IAGWSP indicated PAH detections above MassDEP MCP Method 1 S-1/GW-1 Standards, indicating that potential risk associated with exposure through direct contact to this soil could not be ruled out. However, the PAH concentrations are not considered a leaching threat to groundwater (IAGWSP 2012). Given that Old GP-2 is located on the NWOU at LF-1 with a native soil cover and restricted access provided by the perimeter fence line, it was determined that the PAH detections do not present a risk with current institutional controls and land use restrictions. As a result, the EPA and MassDEP approved a No-Further

Action decision for the Army GP sites in a decision document (IAGWSP 2012) completed under the Safe Drinking Water Act Administrative Order with the understanding that the LUCs that apply to the LF-1 source area as specified in the LF-1 ROD (AFCEE 2007a) under CERCLA would be extended to the NWOU via an ESD which was prepared in 2013 (AFCEC 2013a).

4.3.5 Five Year Review Process

4.3.5.1 Data Review

Data collected at the LF-1 source area have been reported as part of the annual landfill inspection reporting and are documented in the LF-1 SLRs (AFCEC 2013b; AFCEE 2012c, 2011, 2010, 2009, 2008b). In summary, minor maintenance and repairs to the landfill cap system (such as filling minor erosion rills and trimming vegetation) have been required and have been implemented promptly by AFCEC following discovery during inspections. Landfill settlement survey results are within expected ranges and do not identify cause for concern or issues with the integrity of the cap. Landfill gas monitoring results indicate infrequent and generally decreasing low-level detections of methane and total VOCs at the vent ports located throughout the capped landfill but primarily in the ports located in the Post-1970 cell where the highest methane levels have been reported historically since this was the last cell to receive municipal waste (ANG 1993b).

4.3.5.2 Site Inspections

An SI was completed for the LF-1 source area on 19 June 2013. The SI form is included in Appendix B. Since the remedial actions conducted at the LF-1 source area are complete and annual landfill inspections are ongoing and well documented as discussed in Sections 4.3.3.2 and 4.3.5.1, the focus of the SI was to assess general site conditions and to determine whether the land use assumptions are still valid and do not affect protectiveness. Based on the SI, land use at the site remains consistent with the

assumptions used in the risk assessment and no concerns regarding protectiveness were identified.

4.3.5.3 Interviews

Refer to Section 3.6.

4.3.6 Technical Assessment

The technical assessment component of the Five Year Review consists of evaluating the protectiveness of the remedy. The technical assessment is based on EPA guidance provided in Section 4.0 of the Comprehensive Five Year Review Guidance (EPA 2001).

4.3.6.1 Question A: Is the remedy functioning as intended by the decision document?

Based on a review of annual landfill inspection results and assessment of LF-1 groundwater plume remedial progress as discussed in Section 5.13, it can be concluded that the remedy is functioning as intended by the ROD and the RAOs (Section 4.3.3) are being achieved.

4.3.6.2 Question B: Are the exposure assumptions, toxicity data, cleanup level, and RAOs used at the time of remedy selection (current) still valid?

Changes in Standards and To-Be Considered: There have been no changes in standards and to-be considered guidance.

Changes in Exposure Pathways: There have been no changes in the physical conditions and land use of the site that would affect the protectiveness of the remedy.

Due to increased concern related to the VI exposure pathway, a VI screening assessment was conducted for a number of sites at the MMR including LF-1 where the VI exposure pathway related to volatile contaminants in groundwater was determined to be incomplete and further evaluation of VI associated with the LF-1 plume was not

necessary. However, the VI pathway associated with LF-1 source area material was not assessed during this 2012 MMR VI evaluation. A screening has been completed at the LF-1 landfill in accordance with the VI screening process developed and presented in the 2012 VI technical memorandum for the PFSA and FTA-2 source areas (AFCEE 2012a).

Following EPA draft guidance (EPA 2002), the screening process involves determining whether site-related volatile compounds are present in soils within 100 ft of a building or preferential airflow pathway (such as underground utilities). For the purposes of this evaluation at the LF-1 source area, it has been assumed that the landfilled waste within the capped area contains detectable concentrations of volatile compounds. If it can be demonstrated that no buildings or preferential airflow pathway exist within 100 ft of the landfilled waste at LF-1, then the VI pathway can be considered either incomplete or insignificant and no further evaluation is deemed necessary (AFCEE 2012a).

In the vicinity of the LF-1 source area, no structures exist within a 100-ft buffer of the LF-1 source area boundary as identified in **Figure 4-3**. In addition, the source area boundary for most of the landfill is a substantial distance from the edge of the capped area, providing additional buffer.

Figure 4-3 also shows subsurface utilities in the vicinity of the LF-1 source area. Although a treated effluent line runs below the west side of Frank Perkins Road and is located within the 100-ft source area boundary buffer, no underground utilities are located within 100 ft of the edge of landfilled material.

Based on a review of the location of existing buildings and preferential migration pathways, the VI exposure pathway from the LF-1 source area is considered incomplete or insignificant under current land use. Post-closure use of the area within the LF-1 source area boundary is regulated under the MassDEP Solid Waste Regulations, 310 CMR 19.000, (MassDEP 1990), and future construction activities at the landfill (such as the construction of buildings) requires prior written approval from MassDEP and would require buildings to be constructed in a manner that prevents the accumulation of

gas within the structure and all buildings must include gas monitoring and warning systems and may require an active gas venting system (310 CMR 19.143).

While the MassDEP Solid Waste Regulations apply to the area within the LF-1 source area boundary, controls are also in place for areas outside the boundary. Because the LF-1 source area is located on the MMR, future development, including the construction of new buildings potentially around the perimeter of the source area, is controlled through institutional controls specified under the LUC Program which is part of the selected remedy for LF-1 (AFCEE 2007a). Specifically, the ANG has administrative processes and procedures that require approval for all projects involving construction or digging/subsurface soil disturbance at the MMR. In the event construction activities were planned near the LF-1 source area, the IRP would take appropriate measures to address VI concerns as they relate to any future structures and/or underground utilities or other potential preferential airflow pathways.

This VI screening evaluation thus concludes that the VI exposure pathway associated with the LF-1 source area is incomplete or insignificant under current land use and institutional controls are in place to prevent VI exposures in the future.

<u>Changes in Toxicity and Other Contaminant Characteristics</u>: There have been no changes in the toxicity and other contaminant characteristics that would affect the protectiveness of the remedy.

<u>Changes in Risk Assessment Methods</u>: There were no changes in risk assessment methodology.

<u>Review of RAOs</u>: RAOs are appropriate.

4.3.6.3 Question C: Has any other information come to light that could call into question the protectiveness of the remedy?

A solar photovoltaic array construction project is being considered on the capped portion of the LF-1 landfill. Preliminary discussions between AFCEC, EPA, and MassDEP have indicated that since the solar array will be constructed on the landfill cap that is part of a

Federal Superfund project, issuance of a MassDEP Post-Closure Use Permit (typically issued under 310 CMR 19.143) is not required for this project. However, EPA approval is required after it has been demonstrated that the solar array project will not adversely impact the landfill cover and that the project will be maintained in a manner to protect the long term integrity of the cover (i.e., the protectiveness of the remedy will be maintained). To receive approval, EPA has requested AFCEC prepare and submit a technical memorandum that includes the information required by MassDEP under their permitting process as described in the fact sheet *Developing Renewable Energy Facilities on Closed Landfill* (http://www.mass.gov/eea/docs/dep/energy/fslfenergy.pdf) for EPA and MassDEP review.

4.3.7 Issues, Recommendations, and Follow-Up Actions

No issues exist at the present time and the remedy continues to function as intended. Landfill cap operation and maintenance activities should continue as required in the Final ROD (AFCEE 2007a) and identified in the PCM Plan (AFCEE 2012b). Should the solar photovoltaic array construction project be pursued, a technical memorandum as described in Section 4.3.6.3 should be prepared for regulatory review and approval.

4.3.8 Protectiveness Statement

The remedy for the LF-1 source area is protective of human health and the environment. Groundwater monitoring under the LF-1 SPEIM/LTM program (discussed in Section 5.13) does not indicate the LF-1 source area is acting as a continuing source of groundwater contamination. Therefore, the landfill cap system at LF-1 is operating as expected. In addition, the LUCs are in place and are functioning as intended.

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4.4 FIRE TRAINING AREA-2/LANDFILL-2 (FTA-2/LF-2)

FTA-2/LF-2 is located west of the southern end of Runway No. 5, within the flightline security area (**Figure 4-4**). The FTA-2/LF-2 area occupies approximately 25 acres, and includes a former FTA that was located on top of a buried industrial/municipal landfill. Landfill operations at LF-2 began in approximately 1940 and consisted of the disposal of solid waste (e.g., bottles, glass, ash, metal scrap, wood, concrete, and asphalt construction debris). The landfilling activities were discontinued in 1944 and the area was covered with fill material before the fire-training site was developed in 1948. Fire-training activities at FTA-2 began in an unlined depression on the southern part of the landfill that acted as a drainage swale. Sand, asphalt, and concrete rubble fill were apparently placed in the landfill swale before, during, and after fire-training activities. FTA-2 was covered with additional soil following its abandonment in 1956 (ANG 1996).

4.4.1 Site Chronology

1940 - 1944: LF-2 area used for disposal of solid waste.

1948 - 1956: FTA-2 was developed over a small portion of LF-2 and was used for fire training exercises during this period. The structure was abandoned and filled in 1956.

1986: A preliminary assessment (PA) was completed which identifies FTA-2/LF-2 as a potential location of the disposal of hazardous materials (E.C. Jordan 1986).

1988: SIs confirm landfilling operations and evidence of the disposal of oil and hazardous materials at FTA-2/LF-2 (E.C. Jordan 1990).

1996: RIs at FTA-2/LF-2 completed (ANG 1996).

1997-1998: Completion of a feasibility study (AFCEE 1997) and a ROD (AFCEE 1998).

2001-2003: A biosparging system was installed and operated until STCL remedial goals were met. Before reaching final concurrence on the soil remediation, MassDEP required sampling of groundwater for EPH and VPH following MassDEP methods. Select EPH/VPH carbon ranges exceeded MCP Method 1 GW-1 groundwater standards (AFCEE 2005a).

2004-2009: As part of groundwater monitoring associated with the nearby Western Aquafarm site in 2004, 1,2,4-trimethylbenzene (TMB) and 1,3,5-TMB were detected at two monitoring wells within the FTA-2/LF-2 area. In 2005, an interim groundwater LTM program was established within the FTA-2/LF-2 source area while other site characterization work was completed to evaluate the nature and extent of the groundwater contamination. Ten separate groundwater sampling events were conducted between 2004 and 2009. During this period, EPH/VPH carbon range concentrations were consistently reported above the MCP Method 1 GW-1 standards; however, current land use limits human exposure to the groundwater and the contamination does not appear to be migrating beyond the base boundary (AFCEE 2008a).

2010: A project note was prepared that presents an historic overview of the groundwater data collected at FTA-2/LF-2 and also expands the FTA-2/LF-2 LTM network. In this project note, it was agreed by AFCEE, EPA, and MassDEP that groundwater contamination that could potentially be associated with the Western Aquafarm site (now closed), LF-2, and FTA-2 would be associated with the FTA-2 site going forward for reporting purposes (AFCEE 2011).

2011-Present: LTM events were completed at FTA-2 in December 2011, April 2012, and December 2012/January 2013 (AFCEE 2012b, AFCEC 2013).

4.4.2 Background

4.4.2.1 History of Contamination

Landfill operations at LF-2 began in approximately 1940 and were discontinued in 1944. LF-2 contains primarily solid waste (e.g., bottles, glass, ash, metal scrap, wood, concrete,

and asphalt construction debris). However, analytical results from a test pit that was advanced approximately 350 ft south of the FTA-2 indicate the presence of localized areas of petroleum contaminated soil at LF-2 (ANG 1996). The landfill was covered with fill material before fire training activities were conducted at FTA-2 from 1948 to 1956. FTA-2 may have received up to 7,000 gallons per year of waste oil, aviation gasoline (AVGAS), JP-4 fuel, and solvents, which were ignited during fire training exercises (ANG 1996). Sand, asphalt, and concrete rubble fill were apparently placed in a drainage swale before, during, and after fire-training activities at FTA-2. The FTA-2 area was covered with additional soil following its abandonment in 1956.

4.4.2.2 Physical Characteristics, Land and Resource Use

The LF-2/FTA-2 area occupies approximately 25 acres and is located to the west of the runway No. 5 and contained within the flightline secure area. The generally flat surface with subtle surface drainage features consists of un-paved, grassed areas that are mowed and maintained adjacent to the airfield. The minimum and maximum ground surface elevations within the source area boundary are 90 ft msl and 108 ft msl, respectively. Roughly 10 to 20 percent of the source area has some larger scrub pine and vegetation typical of Cape Cod. The area will be maintained as open-space in the foreseeable future while the airfield and runways are in use.

Prior to landfilling in the 1940s, the topography of the FTA-2 area was characterized by a prominent north-south swale that connected to a drainage ditch just south of South Outer Road (Figure 4-4). As a result of landfilling operations that filled this drainage ditch, the FTA-2 area no longer provided effective surface drainage. Storm water drainage pipes were installed to carry runoff southward from the large nearby paved areas to the north and west. Surface soils consist of fill with construction debris and solid waste to a depth of up to approximately 16 ft bgs (ANG 1996). Below that, subsurface soils are predominantly well-graded medium-grained sand with small amounts of fine- to coarse-grained sand, and traces of fine- to coarse-grained gravel, cobbles, and silt. Soils at the FTA-2 area are characteristic of typical glacial outwash comprising the Mashpee Pitted Plain (AFCEE 2003). The depth to groundwater is approximately 45 to 50 ft bgs

throughout the FTA-2 area. The groundwater flow direction at FTA-2 is in a southerly direction (AFCEE 2011).

4.4.2.3 <u>Initial Response</u>

No responses were initiated prior to the PA conducted as part of the CERCLA process.

4.4.2.4 <u>Basis for Taking Action</u>

The RI (ANG 1996) included a human-health PRA to evaluate potential human-health risks associated with exposure to contaminated soil under an occupational (worker) exposure scenario. The calculated cancer risk was within the EPA acceptable risk range and the calculated noncancer hazard index was below one. An ecological PRA was also performed which concluded that there could be adverse effects to ecological receptors, however, because of current and anticipated land use of the site, no additional action was recommended. Cleanup at FTA-2/LF-2 was driven by the potential impact to groundwater by petroleum-related organic compounds in soils.

4.4.3 Remedial Actions

The PA conducted in 1986 identified FTA-2/LF-2 as a potential site of past uncontrolled disposal of hazardous substances (E.C. Jordan Co. 1986). An SI was completed in 1988 (E.C. Jordan Co. 1990). The SI consisted of a soil gas survey, excavation of 18 test pits, installation of two soil borings completed as monitoring wells, soil sampling, and groundwater sampling. The soil gas survey detected trace concentrations of chlorinated solvents. Test pits identified areas of burned refuse and stained soil. The RI (ANG 1996) included the excavation of four test pits, geophysical investigations, surface soil sampling, subsurface soil sampling, and groundwater sampling. Samples were analyzed for VOCs, semivolatile organic compounds (SVOCs), and inorganics. The supplemental RI focused on investigating subsurface soil associated with the firefighter training site. In summary, RI data indicated that the primary soil contaminants of FTA-2/LF-2 were fuel-related VOCs and SVOCs. Inorganics are secondary contaminants in soil at the site. The highest concentrations of VOCs and SVOCs were observed at the FTA-2 burn pit area.

4.4.3.1 Remedy Selection and Implementation

A ROD was signed on 30 September 1998 (AFCEE 1998) which documented the decision to perform a remedial action at FTA-2/LF-2. The selected remedial alternative was biosparging with ambient air monitoring. In summary, the remedy provides for:

- Performance of baseline ambient air monitoring;
- Collecting confirmation soil samples to refine the horizontal and vertical delineation of the target contaminants ethylbenzene and total xylenes;
- Designing and installing a full-scale biosparging treatment system;
- Collecting ambient air samples to assess compliance with ARARs;
- Maintaining institutional controls that restrict site access and limit potential human exposure to contaminants.

Investigations conducted at FTA-2/LF-2 indicated that source area soil may be a source of ethylbenzene and total xylenes to groundwater through leaching. The presence of these compounds in soil could result in an unacceptable risk to those who drink groundwater at or downgradient of the source area. Therefore the MMR-specific STCLs established for the DSRP (AFCEE 1996) were retained as RALs for the identified COCs (i.e., ethylbenzene and total xylenes). Specifically, the RAO for FTA-2/LF-2 as presented in the ROD is:

- Prevent organic compounds in soils associated with FTA-2 from being a source of groundwater contamination.

The RALs for ethylbenzene and total xylenes in soil were established as 700 µg/kg, and 10,000 µg/kg, respectively (AFCEE 1998).

A biosparge treatment system was installed at FTA-2/LF-2 and began operation in September 2001. The treatment system consisted of an air compressor, a regenerative blower, a moisture separator, a heat exchanger, carbon vessels and a condensate-holding tank. The system design combined 90 cubic feet per minute (cfm) of sparging capacity with 180 cfm of extraction capacity (AFCEE 2002). The biosparge treatment system was shut down in May 2003 after the remedial goals for soil were met (i.e., the RALs for

ethylbenzene and total xylenes in soil were achieved) such that soils are no longer considered a potential source of groundwater contamination through leaching. Petroleum hydrocarbons do remain in soil, therefore, UU/UE conditions have not been met and the institutional controls specified as part of the remedy are required to maintain protectiveness (AFCEE 2010a). In addition, a component of the institutional controls was to document the presence of a landfill at LF-2 through a deed notification per the MassDEP solid waste regulations (310 CMR 19.141). AFCEC, working with the base real estate office and the Commonwealth who owns the property, have been unable to determine whether a deed for this parcel is in existence. Therefore, the deed notification will be filed at the Base Real Property office which will meet the intent of the deed notification regulatory requirement.

In order to obtain approval for a completed remedial action from the MassDEP, groundwater in the immediate vicinity of the biosparging system was sampled for EPH and VPH analysis by the MassDEP Method. Details of the groundwater sampling events completed since the shutdown of the biosparge treatment system are as follows:

<u>Groundwater Sampling Event (December 2004)</u>: In December 2004, under the Western Aquafarm groundwater monitoring program, TMB isomers (1,2,4-TMB and 1,3,5-TMB) were detected in two monitoring wells located at LF-2/FTA-2. In subsequent discussions with EPA and MassDEP, it was determined that the TMB detections would be more appropriately addressed under the LF-2/FTA-2 groundwater monitoring program (AFCEE 2005b).

<u>Groundwater Sampling Event (October 2005)</u>: Eleven groundwater monitoring wells were sampled at FTA-2/LF-2 in October 2005. Samples were analyzed for inorganics, VOCs (including the TMB isomers), SVOCs, EPH/VPH, pesticides, and PCBs. Eight of 11 locations had EPH/VPH concentrations above MCP GW-1 standards. Arsenic was detected above the MCP GW-1 standard at five locations. The arsenic detections could be the result of reducing conditions in groundwater due to the presence of EPH/VPH. Pesticides, PCBs, SVOCs, and other VOCs were not detected above MCP GW-1 standards (AFCEE 2005a).

Groundwater Sampling Event (December 2005): Groundwater samples were collected from three monitoring wells in December 2005 as part of the newly established FTA-2/ LF-2 LTM network (AFCEE 2005b). The groundwater samples were analyzed for VOCs (including TMB). Ethylbenzene was detected at one location above the MCL of 700 µg/L. In addition, elevated concentrations of the TMB isomers were reported (AFCEE 2006b). Based on the results of this initial LTM sampling event, the network was reduced to one well beginning in 2006.

Groundwater Sampling Event (January 2006): Ten groundwater samples were collected using the AFCEC-owned Geoprobe® at the FTA-2/LF-2 source area in January 2006 for investigative purposes (AFCEE 2006a). All groundwater samples were analyzed for inorganics, VOCs (including the TMB isomers), SVOCs, EPH/VPH, pesticides, and PCBs. Arsenic and C_{11}-C_{22} aromatic hydrocarbons were detected in one sample at concentrations that exceed MCP GW-1 standards.

Groundwater Sampling Event (November 2006): Sixteen groundwater monitoring wells at FTA-2/LF-2 were sampled and analyzed for EPH/VPH and the two isomers of TMB in November 2006. Six of the 16 samples had EPH/VPH carbon range concentrations that exceeded MCP GW-1 standards (AFCEE 2008a).

Groundwater Long Term Monitoring (2006-2012): In 2006, 2007, 2008, and 2009 one well was sampled under the interim LTM program (AFCEE 2007, 2008b, 2009, 2010b). Subsequent evaluation in 2010 and 2011 resulted in the development of an expanded LTM network of nine wells (AFCEE 2011). This LTM network has been monitored since that time and results have been presented in annual project notes (AFCEE 2012b, AFCEC 2013). In general, since biosparging ceased at FTA-2, the petroleum hydrocarbon-related contaminants have continued to naturally attenuate with some short-term increases in select analytes but general downward trends. Monitoring near the base boundary suggests that petroleum hydrocarbon contamination in groundwater at FTA-2 does not appear to be migrating beyond the base boundary (AFCEC 2013).

4.4.3.2 Remedy Operations & Maintenance

Not applicable since no active treatment is ongoing at FTA-2/LF-2.

4.4.4 Progress Since Last Five Year Review

Per the EPA guidance document (EPA 2001), this section summarizes the progress made on the specific recommendations and follow-up actions presented in the prior third CERCLA Five Year Review (AFCEE 2008a). For the FTA-2/LF-2 source area, the recommendations were:

1) Conduct a reassessment of site data and current standards to determine if, based on future residential exposure, an unacceptable risk remains. In some cases, this may lead to the need to collect additional samples and/or conduct a risk assessment based on future residential exposure (using up-to-date toxicity data and exposure pathways). If this reassessment indicates that the site may still pose an unacceptable risk, then either (1) conduct additional cleanup to levels that allow for unlimited use and unrestricted exposure, or (2) issue a decision document implementing enforceable institutional controls preventing uses for which the site may still pose an unacceptable risk.

2) Determine nature and extent of EPH/VPH contamination at FTA-2/LF-2.

Progress since the last Five Year Review against these recommendations are as follows:

1) A draft *Fire Training Area-2 (FTA-2)/Landfill-2 (LF-2) Remedial Action Report* (AFCEE 2010a) is in preparation and includes a reassessment of the site data, particularly for FTA-2 soils, to determine if UU/UE may be met. However, this document is not yet complete and is inconclusive with regard to whether UU/UE standards are met. Given that groundwater LTM results indicate petroleum hydrocarbons remain in FTA-2 groundwater above MassDEP MCP Method 1 Standards (AFCEC 2013), it can be concluded that the site does not meet UU/UE

requirements. In addition, landfilled material remains at LF-2 and institutional controls are required as specified in the ROD (AFCEE 1998).

2) The groundwater investigations and LTM activities described in Section 4.4.3.1 have improved the understanding of the nature and extent of the EPH/VPH contamination in groundwater at FTA-2/LF-2. In addition, an LTM network has been established at FTA-2 and routine groundwater monitoring is being conducted.

4.4.5 Five Year Review Process

4.4.5.1 Data Review

Groundwater monitoring has been conducted at FTA-2 during this Five Year Review period as part of the LTM program. The results from this monitoring are documented in several LTM reports (AFCEE 2007, 2008b, 2009, 2010b, 2011, 2012b; AFCEC 2013). **Table 4-2** presents the most recent detections reported in groundwater sampled from the wells included in the current FTA-2 LTM network. Of the nine wells sampled, petroleum-related compounds were detected at concentrations above groundwater standards (MCLs, MCP Method 1 GW-1 standards, or a risk-based concentration (RBC) of 17 µg/L developed for TMBs at FS-13 [see Section 5.10]) in four of the monitoring wells (**Figure 4-4**).

No ethylbenzene or total xylenes were detected in groundwater at concentrations above their respective MCLs indicating that the biosparge treatment system was effective in achieving its goal of reducing concentrations of the FTA-2 soil COCs to levels that do not act as a continuing source of groundwater contamination. However, C_5-C_8 aliphatics (VPH), C_9-C_{10} aromatics (VPH), C_9-C_{12} aliphatics (VPH), and C_{11}-C_{22} aromatic (EPH) carbon ranges continue to be detected in FTA-2 groundwater at concentrations greater than the MCP Method 1 GW-1 groundwater standards. In addition, the TMB isomers and 2-methynapthalene were reported in groundwater at concentrations above the standards presented in **Table 4-2**.

4.4.5.2 Site Inspections

An SI was completed for FTA-2/LF-2 on 10 July 2013. The SI form is included in Appendix B. Since the remedial action conducted at FTA-2/LF-2 (i.e., operation of the biosparging treatment system) is complete, the focus of the SI was to assess general site conditions and to determine whether the land use assumptions are still valid and do not affect protectiveness. Based on the SI, land use at the site remains consistent with the assumptions used in the risk assessment, access to the site is restricted, and no concerns regarding protectiveness were identified.

4.4.5.3 Interviews

Refer to Section 3.6.

4.4.6 Technical Assessment

The technical assessment component of the Five Year Review consists of evaluating the protectiveness of the remedy. The technical assessment is based on EPA guidance provided in Section 4.0 of the Comprehensive Five Year Review Guidance (EPA 2001).

4.4.6.1 Question A: Is the remedy functioning as intended by the decision document?

Operation of the biosparging system has clearly mitigated further impact to groundwater from the COCs identified in the ROD (i.e., ethylbenzene and total xylenes) and the soil remedial goals specified in the ROD have been met. However, petroleum hydrocarbon-related compounds do remain in soil at concentrations exceeding EPA Industrial RSLs so UU/UE conditions have not been met (AFCEE 2010a). Petroleum hydrocarbon contamination (i.e., EPH/VPH, TMBs, and 2-methylnaphalene) attributed to FTA-2 has been detected in groundwater above MCP Method 1 GW-1 cleanup standards in recent years. Monitoring data suggest that this contamination is degrading, does not appear to be migrating, and has not moved beyond the base boundary. Current on-base land use management procedures and the flightline security measures, which include fencing and 24-hour security, effectively limit potential human exposure to the site contaminants

located on-base. The remedy presented in the ROD did not directly address groundwater contamination.

4.4.6.2 Question B: Are the exposure assumptions, toxicity data, cleanup level, and RAOs used at the time of remedy selection still valid?

Changes in Standards and To-Be Considered: There have been changes in MassDEP standards for soil; however, the ROD soil cleanup levels for ethylbenzene and total xylenes are much more stringent (i.e., less than the MCP Method 1 S-1 Standards).

Changes in Exposure Pathways: There have been no changes to exposure pathways or land use of the site that would affect the protectiveness of the remedy. However, the groundwater media was not directly considered at the time of the remedy selection, therefore the groundwater exposure pathway should be further evaluated based on the recent history of groundwater monitoring data.

Since the VI exposure pathway was not considered during the RI, a screening evaluation of the VI pathway was completed at FTA-2/LF-2 for both soil and groundwater (AFCEE 2012a).

VI COPCs in soil are not located within 100 ft of any existing buildings but are located within 100 ft of subsurface utilities that could act as preferential airflow pathways. However, associated VI impacts are unlikely due to the relatively long travel distances (over 1,000 ft) between the soil VI COPCs and nearest existing buildings.

VI COPCs in groundwater have not been detected within 100 ft of any existing buildings; however, three monitoring wells where VI COPCs are detected above VI screening levels are located within 100 ft of subsurface utilities. VI impacts from the FTA-2 area groundwater are unlikely due to the nature of the utilities and the nearby buildings, relatively long travel distances involved, relatively small magnitudes of the VI screening level exceedances, and generally decreasing VI COPC concentrations in groundwater (AFCEE 2012a). Since the FTA-2/LF-2 source area is located on the MMR, future development, including the construction of new buildings in this area, is controlled by

on-base entities that have administrative processes and procedures that require approval for all projects involving construction or digging/subsurface soil disturbance at the MMR. These processes should be adopted as LUCs through issuance of a decision document.

Changes in Toxicity and Other Contaminant Characteristics: There were no changes in toxicity and other contaminant characteristics.

Changes in Risk Assessment Methods: There were no changes in risk assessment methodology.

Review of RAOs: RAOs need to be developed to address the petroleum hydrocarbon contamination identified in groundwater post-ROD.

4.4.6.3 Question C: Has any other information come to light that could call into question the protectiveness of the remedy?

There is no other information at this time that calls in to question of the short-term protectiveness of the remedy based on current land use. The FTA-2/LF-2 site is located within installation boundaries (and the flightline area) and exposure pathways for humans are currently controlled or mitigated by DoD land use and management practices.

The petroleum hydrocarbon contamination (e.g., EPH/VPH, TMB isomers, and 2-methylnapthalene) that has been identified in groundwater above groundwater standards and/or RBCs (**Table 4-2**) requires that further remedial actions are necessary since RAOs directly related to groundwater are not included in the ROD.

4.4.7 Issues, Recommendations, and Follow-Up Actions

Continue to monitor FTA-2 groundwater under the current LTM plan defined in 2010 (AFCEE 2011). A focused feasibility study to assess remedial alternatives for FTA-2 groundwater should be developed. The focused feasibility study will include an updated conceptual exposure model and RAOs addressing the groundwater media for the petroleum-related compounds. AFCEC's preferred remedy for groundwater will be

presented in a proposed plan available for public review and comment. The selected remedy for groundwater will be documented in an amendment to the existing ROD (AFCEE 1998). A component of the remedy for FTA-2 groundwater should include enforceable LUCs to ensure long-term protectiveness similar to the other IRP groundwater sites (see Section 5.0). In addition, and similar to the other IRP groundwater sites, the LUCs should adopt the administrative processes and procedures for on-base development activities, including the construction of new buildings, to provide long-term protectiveness for the VI exposure pathway. Future Five Year Reviews should include assessment of both the FTA-2/LF-2 source area and FTA-2 groundwater.

In addition, a component of the institutional controls was to document the presence of a landfill at LF-2 through a deed notification per the MassDEP solid waste regulations (310 CMR 19.141). AFCEC, working with the base real estate and the State who owns the property, have been unable to determine whether a deed for this parcel is in existence. Therefore, the deed notification will be filed at the Base Real Property office which will meet the intent of the deed notification regulatory requirement. This action will be documented in the ROD Amendment.

4.4.8 Protectiveness Statement

The remedy for the FTA-2/LF-2 source area is protective of human health and the environment in the short-term under the current land use scenario. The remedy is protective in the short-term since access to the site is controlled by current flight line security measures which include fencing and 24-hour security that effectively limits potential human exposure to site contaminants. For the remedy to be protective in the long-term, it is recommended that additional remedial actions be implemented to address petroleum-related contamination in groundwater that was not directly addressed by the selected remedy presented in the ROD.

4.4.9 References

AFCEC. 2013 (March). *Fire Training Area-2 (FTA-2) Long Term Monitoring 2012 Project Note.* 437075-SPEIM-FTA2-PRJNOT-001. Prepared by CH2M HILL for AFCEE/MMR, Installation Restoration Program, Otis Air National Guard Base, MA.

AFCEE. 2012a (August). *Final 2011 MMR Vapor Intrusion Evaluation Technical Memorandum*. 420005-SPEIM-MULTIPLE-TECHMEM-002. Prepared by CH2M HILL for AFCEE/MMR, Installation Restoration Program, Otis Air National Guard Base, MA.

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ANG. 1996. *Remedial Investigation Report Fire-Training Area No.2 (FTA-2) and Landfill No.2 (LF-2).* Prepared by ABB-ES for AFCEE/MMR Installation Restoration Program, Otis ANG Base, MA.

E.C. Jordan Co., 1990 (June). "*Task 2-5B Site Inspection, Field Investigation Work Conducted Spring-Summer 1988'; Installation Restoration Program;* Massachusetts Military Reservation. Prepared for HAZWRAP; Portland, Maine.

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EPA. 2001 (June). *Comprehensive Five-Year Review Guidance*, EPA 540R-01-007.

4.5 LANDFILL-7 (LF-7)

LF-7 is approximately 400 square feet (ft^2) and is located in a former gravel pit north of the LF-1 source area (Figures 1-2 and 4-5). It is an area where radioactive electron tubes, removed from EC-121 aircraft radar sets, were reportedly buried. The number buried is unknown, however, since approximately 200 tubes/year were removed from aircraft between 1955 and 1970, it is estimated that as many as 3,000 tubes may be buried (ANG 1993).

4.5.1 Site Chronology

1992: ANG investigation of radioactive isotopes used in radar tubes that were potentially disposed of at LF-7 (ANG 1993).

1993: The decision document concludes that the potential hazard from disposed radar tubes is negligible; however, in accordance with Air Force Office of Medical Support (AFOMS/SGPR) policy letter of August 9, 1988 areas used for disposal of low-level radioactive wastes are to be fenced to prevent unauthorized entry, marked with radioactive warning labels, and annual radiological surveys are to be conducted (ANG 1993).

1993 to Present: Annual inspections of the security fencing/signage and annual radiation surveys conducted.

2012: The Consultative Services Division of the U.S. Air Force School of Aerospace Medicine (USAFSAM/OEC) completed a radiation scoping survey (USAF 2013).

4.5.2 Background

4.5.2.1 History of Contamination

Although unknown, burial of radar tubes is suspected to have occurred between 1955 and 1970 at LF-7.

4.5.2.2 Physical Characteristics, Land and Resource Use

The LF-7 area is located north of the LF-1 source area in a wooded buffer area adjacent to cleared training area of Camp Edwards. The grassed area inside the 400 ft^2 fenced area is located approximately 200 ft west of the intersection of Dolan Road and Turpentine Road (Figure 4-5). The approximate ground surface elevation at LF-7 is 130 ft msl.

4.5.2.3 Initial Response

Not applicable.

4.5.2.4 Basis for Taking Action

In response to discussions with the EPA on May 19, 1992, the ANG investigated the nature of the radioactive isotopes used in the radar tubes potentially disposed of at LF-7. Based in discussions with ANG and Air Force personnel, the most likely radioactive isotopes used in the electron tubes were Cesium-137, Tritium, Nickel-63, Cobalt-60, and Radium-226 (ANG 1993).

These radar electron tubes are believed to have contained very low, near background, levels of radioactive material ranging from 10^{-7} to 10^{-9} picoCuries (pCi). Using the estimated number of tubes and their pCi range, the total radioactivity at this study area was calculated to be in the 3×10^{-4} to 3×10^{-6} pCi range. It was concluded that were the entire amount of radioactivity to be contained in one liter of water, the level of radioactivity would be, at worst, 3×10^{-4} pCi/L. The Federal MCLs for radium and gross Alpha radioactivity in drinking water are 5 and 15 pCi/L, respectively (available at: http://water.epa.gov/drink/contaminants/index.cfm#Radionuclides). The worst-case concentrations calculated above are negligible compared to the MCLs (ANG 1993).

4.5.3 Remedial Actions

This section presents regulatory actions, a description of the selected remedy, and a summary of the remedy implementation at LF-7.

4.5.3.1 Remedy Selection and Implementation

The LF-7 decision document was signed on 17 November 1993. The decision document requires the construction of a fence surrounding the study area to prevent unauthorized entry and excavation activities, the posting of appropriate radioactive warning labels, and the conducting of annual radiological surveys (ANG 1993). The fence and signage was already in place at the time the decision document was completed and three annual inspections had already been completed in June 1991, June 1992, and June 1993. Reports for these annual inspections were appended to the decision document.

4.5.3.2 Remedy Operations & Maintenance

The study area has operated in full accordance with AFOMS/SGPR policy letter of August 9, 1988. This policy specifies that areas used for disposal of low-level radioactive wastes will be appropriately fenced to prevent unauthorized entry, marked with appropriate radioactive warning labels, and monitored annually to verify that actual levels of radioactivity remain acceptable. The annual radiological survey has been conducted since 1991 and reports are on file with the IRP at the MMR. There has never been a radiation reading above background levels during these annual surveys. These surveys of the 20-ft by 20-ft area have been conducted at the ground surface and 3 ft above the ground surface. The institutional controls will be in place as long as MMR remains a military base. Levels of radioactivity considered acceptable are (1) less than two times background; or (2) 2 milliRoentgen/hour, whichever is lower (Nuclear Regulatory Commission regulations 10 CFR 20.105).

4.5.4 Progress Since Last Five Year Review

Per the EPA guidance document (EPA 2001), this section summarizes the progress made on the specific recommendations and follow-up actions presented in the prior third CERCLA Five Year Review (AFCEE 2008). For LF-7, the recommendations and follow-up actions were:

1) Identify a site closure plan.

Progress since the last Five Year Review against these recommendations is as follows:

1) The USAFSAM/OEC completed a sensitive radiological survey. The objective of the survey was to determine the presence of radioactive material contamination at the site. The results are described in Section 4.5.5.1.

4.5.5 Five Year Review Process

4.5.5.1 Data Review

In 2012, the USAFSAM/OEC completed a radiation scoping survey of the LF-7 site at the MMR. The survey was completed between 09 and 13 July 2012 and was performed to confirm the existence of radioactive materials related to suspected disposal of radar tubes and involved very sensitive instrumentation for in situ scanning measurements, vegetation sampling to evaluate potential food chain impacts, and soil sampling. Vegetation and soil samples were submitted for laboratory analysis of radioactivity. The results from this survey will be used as a basis of information for future decisions to perform additional investigations and/or remediation of the site (if applicable) and to evaluate potential health hazards to hypothetical future site residents (USAF 2013).

The survey work concluded that no radioactive materials were found at LF-7 that indicate there is a widespread high level of contamination or contamination that poses an immediate threat to the environment and personnel. All detected levels of Cesium-137, Cobalt-60, Tritium, and Nickel-63 were well below the U.S. Nuclear Regulatory Commission’s screening levels and indicate that there is no contamination from these radionuclides. However, the survey did not conclusively rule out the presence of radium at levels above the U.S. Nuclear Regulatory Commission’s screening levels. Therefore, to make a final determination regarding Radium-226, further investigation should be performed to determine whether remedial actions are needed at LF-7.

4.5.5.2 Site Inspections

Routine annual inspections are completed at LF-7 as part of the remedy. During this Five Year Review Period, annual inspections were completed on 24 September 2008, 30 September 2009, 29 October 2010, 06 October 2011, and 31 October 2012.

An SI was completed for LF-7 as part of this Five Year Review on 19 June 2013. The SI form is included in Appendix B. The focus of the SI was to assess general site conditions including the fence and signage and to determine whether the land use assumptions are still valid and do not affect protectiveness. Based on the SI, the fence and signage are present and in good condition and land use at the site remains consistent with the assumptions presented in the decision document and no concerns regarding protectiveness were identified.

4.5.5.3 Interviews

Refer to Section 3.6.

4.5.6 Technical Assessment

The technical assessment component of the Five Year Review consists of evaluating the protectiveness of the remedy. The technical assessment is based on EPA guidance provided in Section 4.0 of the Comprehensive Five Year Review Guidance (EPA 2001).

4.5.6.1 Question A: Is the remedy functioning as intended by the decision document?

The review of documents and the results of annual SIs and radiological surveys indicate that the remedy is functioning as intended by the decision document. Annual monitoring has been conducted since 1991 (22 years). There has never been a radiation reading above background levels during these annual surveys and the fence and signage is in good condition and performing as intended. Minor repairs to the fencing or signage have been conducted when necessary.

4.5.6.2 Question B: Are the exposure assumptions, toxicity data, cleanup level, and RAOs used at the time of remedy selection (current) still valid?

Changes in Standards and To-Be Considered: There have been no changes in standards and to-be considered.

Changes in Exposure Pathways: There have been no changes in the physical conditions and exposure pathways of the site that would affect the protectiveness of the remedy. Due to added concern related to the VI exposure pathway, a VI screening assessment has been conducted for a number of release sites at the MMR (AFCEE 2012) but not LF-7. VI exposure pathway screening is not deemed necessary at LF-7 since volatile compounds are not associated with the site.

Changes in Toxicity and Other Contaminant Characteristics: There were no changes in toxicity and other contaminant characteristics.

Changes in Risk Assessment Methods: Not applicable.

Review of RAOs: Not applicable.

4.5.6.3 Question C: Has any other information come to light that could call into question the protectiveness of the remedy?

No.

4.5.7 Issues, Recommendations, and Follow-Up Actions

There are no issues with regards to protectiveness at LF-7 and continued annual inspections and radiological surveys should be conducted per the Decision Document. AFCEC will continue to determine whether the site can reasonably meet UU/UE site closure requirements.

4.5.8 Protectiveness Statement

The remedy for the LF-7 source area is protective of human health and the environment. The LUCs (i.e., fence and signage) at LF-7 are functioning as intended and the annual radiological surveys do not indicate the presence of radiation above background levels at the ground surface or at three feet above the ground surface within the fenced area. However, it is recommended that additional investigation and potentially remediation be completed at LF-7 with regards the presence of Radium-226 to determine whether the site can meet UU/UE site closure requirements.

4.5.9 References

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USAF. 2013 (March). *Consultative Letter, AFRL-SA-WP-CL-2013-0003, Stored Radioactive Material Landfill Site #7 (LF-7), Massachusetts Military Reservation, Cape Cod, MA*.

4.6 PETROLEUM FUELS STORAGE AREA (PFSA)

The PFSA is located on the north side of South Outer Road and served as the storage and distribution center for JP-4 jet fuel, AVGAS, motor gasoline, and No. 2 fuel oil for MMR from the 1950s until 2009 (**Figure 4-6**). The PFSA has been the location of several fuel spills and has historically been referred to as PFSA (FS-10/FS-11) but will here-after be referred to as PFSA in this document. Demolition of the PFSA facility was completed in early 2011 (demolition areas shown on **Figure 4-6**). Over the years, the facility consisted of three above ground storage tanks (ASTs), several USTs, above ground and below ground fuel distribution lines, pump houses, and truck fill stands. Recently demolished ASTs (shown on **Figure 4-6** as ASTs 15 and 16) were 0.5 and 1.2 million gallons in capacity. A third large AST (0.5 million gallons) was once present to the west of Tank 16 (**Figure 4-6**); this AST was removed in 1998 (AFCEE 2003). The USTs and other infrastructure related to the fuel distribution system were removed prior to 1998 as discussed in Section 4.6.2.1.

4.6.1 Site Chronology

The following major activities, investigations, and remedial actions were conducted at PFSA:

Early 1950s - 2009: The PFSA operated as the main fuel delivery and distribution area for the flightline.

1985 - 1986: Field investigations (R.F.Weston, Inc. 1985 and E.C. Jordan Co. 1988) identified the presence of soil and groundwater contamination at PFSA.

1987 - 1988: The "Mashpee Groundwater Study" (E.C. Jordan 1990) found soil contamination at the water table in a boring south of the PFSA across South Outer Road and identified fuel-related contamination in groundwater.

1994: An interim RI was performed to characterize groundwater contamination and evaluate potential site risks (ANG 1994).

1996: The Final RI Report (ANG 1996) was completed, with results of the SI, interim RI, and MMR DSRP sampling at the PFSA forming the basis of the RI report.

1997-1998: Completion of a feasibility study (AFCEE 1997) and a ROD (AFCEE 1998).

2001–2012: A biosparge/vapor recovery (BSVR) treatment system was installed as part of the remedy presented in the ROD. The BSVR system started operation in October 2001 and was operated under an approved O&M Plan (AFCEE 2003). In support of treatment system optimizations and eventual shutdown of the BSVR system in April 2010, soil and groundwater samples were analyzed for the ROD COCs, ethylbenzene and total xylenes. Samples were also analyzed for EPH/VPH by the MassDEP Method. EPH/VPH were not identified as COCs in the ROD, but analysis of these compounds was requested by MassDEP.

4.6.2 Background

4.6.2.1 History of Contamination

The PFSA (now demolished) served as the storage and distribution center for JP-4 jet fuel, AVGAS, motor gasoline, and No. 2 fuel oil for MMR from the 1950s until 2009. Historically, fuel received or stored at the PFSA was transferred through underground pipelines to the fuel distribution pump houses. From 1955 to 1965 AVGAS and JP-4 were delivered to the PFSA from the railroad fuel pumping station at MMR (located approximately 9,500 ft west of the PFSA near the intersection of Kittredge and Turpentine Roads). From 1965 to 1973, AVGAS and JP-4 were delivered to the MMR through a 3-inch-diameter underground pipeline extending from the Cape Cod Canal to the PFSA (AFCEE 2012a). Fuels were subsequently delivered by truck to the PFSA and then distributed by truck to aircraft or other points of use (ANG 1996).

Two of the ASTs (ASTs 15 and 16 shown on Figure 4-6) were constructed with floating lids, allowing rainwater and condensation to enter and migrate to the bottom of each of the tanks. This water was reportedly removed from the tank bottoms by opening drain valves and discharging the accumulated water to the containment berms that surrounded

the ASTs until fuel product discharge was observed. The floating lids on the ASTs 15 and 16 were replaced with solid lids in 1977 and 1988, respectively (AFCEE 2012a).

Discharges from the AST containment berms and paved surfaces at fuel unloading areas typically entered storm drain catch basins via asphalt-lined ditches and then exited to the MMR storm water sewer system and then ultimately to the oil-water separator (OWS) located on the southeast side of South Outer Road (**Figure 4-6**). The OWS discharged to a drainage ditch (referred to as SD-2) which lies south of the far eastern portion of PFSA source area boundary (**Figure 1-2** and **Figure 4-6**). Two 42-inch-diameter storm drains and the OWS discharged to the upstream end of SD-2 until their removal in 2002 (AFCEE 2008b). The SD-2 source area has achieved UU/UE status as presented in **Table 1-1a**.

Floor drains in the PFSA pump houses formerly discharged to two nearby French drains that were replaced in 1989 with a 2,000-gallon UST located east of former Building 173. Fuel-contaminated water was historically discharged from fuel/water separator equipment located in the pump houses to the floor drains when filters in the separators were changed (AFCEE 2012a). Four 50,000-gallon USTs were installed northwest of AST 15 in 1956 and were used to dispense AVGAS (that was received from the PFSA) via an underground pipeline to aircraft on the maintenance ramp. The fuel line from the PFSA to these USTs was abandoned in the early 1970s, and these USTs were removed in 1994 (ANG 1996, AFCEE 2008a).

The following summarizes the history of documented releases at PFSA.

1960s: Fuel spills, identified as FS-10 and FS-11, occurred at the PFSA. FS-10 consisted of a release of 2,000 gallons of JP-4 to a floor drain in one of the pump houses. FS-11 consisted of the release of approximately 2,000 gallons of jet fuel to the ground surface from overfilling one of the ASTs.

1996: In June 1996, heavy rain and a pump failure at the PFSA caused 6,000 gallons of fuel-contaminated water to spill from a fuel pump house (Building 173 on **Figure 4-6**). Of the 6,000 gallons, about 300 gallons was diesel and/or jet fuel. Because of high stormwater flows, some fuel discharged to the SD-2 drainage ditch located to the south of the PFSA.

4.6.2.2 Physical Characteristics, Land and Resource Use

The PFSA site occupies approximately 13 acres and is located on the southeast corner of the MMR (**Figure 1-2** and **Figure 4-6**) on-base property. The PFSA infrastructure (now demolished) occupied approximately five acres of relatively flat terrain; the minimum and maximum ground surface elevations within the source area boundary are 82 ft msl and 112 ft msl, respectively. The former PFSA infrastructure was located to the north of South Outer Road, which bisects the site. AFCEC's Sandwich Road Treatment Facility (SRTF) (Building 561) and O&M Building (Building 587) are located within the PFSA source area boundary to the south of South Outer Road. It is in this area where the PFSA BSVR treatment system (now shut down) is located. The former PFSA infrastructure (i.e., the area north of South Outer Road) is located inside the flightline security area which includes fencing and 24-hour security. The area to the south of South Outer Road is also fenced. Current land use in this area is expected to be maintained for the foreseeable future while the airfield and runways are in use and remedial actions are ongoing.

The depth to groundwater is approximately 40 to 55 ft bgs throughout the PFSA site. The PFSA site is approximately 3,800 ft north of Johns Pond (**Figure 1-2**), and groundwater flows from the PFSA in a south-southeast direction towards the northwest corner of the pond.

4.6.2.3 Initial Responses

Drainage Structure Removal Program (1993): As part of the DSRP, the pump house French drains, the storm-sewer catch basin, and associated contaminated soil were removed in 1993 (AFCE 2008b).

Fuel Distribution Line Realignment (1993): The fuel distribution lines at the PFSA were upgraded from below ground to an aboveground system in 1993. Approximately 10 cubic yards of fuel-contaminated soil was excavated from around the subsurface fuel lines during construction activities (AFCEE 2012b).

Demolition of Buildings and UST Removal (1994): Several pump house buildings were demolished and four associated 50,000-gallon USTs were removed from the PFSA in November 1994 (AFCEE 2012b).

Fuel Spill Cleanup (1996): In response to the release of approximately 6,000 gallons of oil/water mixture in 1996 as described in Section 4.6.2.1, 480 cubic yards of fuel-contaminated soil were removed from the PFSA, and 120 cubic yards of fuel-contaminated soil was excavated from the SD-2 drainage ditch as part of an Immediate Response Action performed under the MCP. The excavated soils were transported off site to Bardon Trimount of Stoughton, Massachusetts for asphalt-batching. An SVE system was installed as part of the Immediate Response Action to remove the remaining localized contamination associated with the release (AFCEE 1998). This SVE system was intended to only address the contamination north of Building 173 (**Figure 4-6**) and should not be confused with the larger PFSA BSVR system installed south of South Outer Road later as part of the selected remedy for PFSA as presented in the ROD.

AST Demolition (2010/2011): Although not considered initial responses, ASTs 15 and 16 and Buildings 171, 172, and 173 at the PFSA were removed in January/February 2011 as non-CERCLA related actions. The AST to the west of AST 16 had previously been removed in 1998 (AFCEE 2003). The buildings and AST 15 were removed with no evidence of contamination. Contaminated soil was encountered during the dismantling of

AST 16 and 1,056 gallons of fuel oil, 550 gallons of oily water, and 760 cubic yards of oil-impacted sand were removed for off-site disposal as part of an Immediate Response Action under the MCP (Horsley Witten 2011). Excavation activities were not successful in achieving background conditions in the entire AST 16 area, and additional SI was recommended to fully delineate the vertical and horizontal extent of the impacted soils (AFCEE 2012c). In February 2012, a soil boring was advanced from the ground surface to the water table within the footprint of the AST. The soil and groundwater vertical profiling data indicated that the 2011 release from AST 16 did not impact the groundwater at the PFSA (AFCEE 2012c).

4.6.2.4 Basis for Taking Action

The RI included a human-health PRA to evaluate potential human-health risks associated with exposure to contaminated soil under an occupational (worker) exposure scenario. The calculated cancer risk was within the EPA acceptable risk range and the calculated noncancer hazard index was below one. Because ecological receptors are not anticipated at the PFSA; a quantitative ecological PRA was not completed (AFCEE 2008b). Cleanup at PFSA was driven by the potential impact to groundwater by petroleum-related organic compounds in soils.

4.6.3 Remedial Actions

The RI (ANG 1996) concluded that the highest concentrations of petroleum-related contamination at PFSA appeared to have originated from the area of the three ASTs and the two pump houses. It stated that fuel-related contamination leached from sources in a dissolved phase in percolating groundwater or via the downward migration of free-product releases, creating capillary fringe soil contamination. More recent data collected since the RI indicate that the capillary fringe soil contamination is present between approximately 54 and 64 ft bgs in the western portion of the PFSA, and between approximately 38 to 58 ft bgs in the eastern portion of the PFSA. The approximate extent of the soil contamination, based on a delineation completed in 2003 (AFCEE 2003), is shown on **Figure 4-6**. The typical depth to groundwater in the vicinity of this capillary

fringe soil contamination is approximately 40 to 55 ft bgs. The RI also indicated that most of the groundwater contamination resulted from direct leaching from capillary fringe soils. Near-surface soil sampling at the ASTs did detect contamination that was attributed to the discharge of petroleum-contaminated water and/or fuel product drained from tank bottoms and was estimated to impact a total of 2,100 cubic yards of soil. Soil sampling confirmed that the French drains at the pump house buildings had been sources of fuel-related contamination and also several chlorinated compounds. The total volume of fuel-contaminated soil at the capillary fringe beneath the PFSA was estimated at 69,000 cubic yards. The RI recommended a feasibility study to assess remedial options to address the shallow and deep contaminated soil.

A focused feasibility study (AFCEE 1997) was conducted to evaluate remedial options to address the PFSA contamination. Shallower soil contamination was determined to not pose a threat to future utility workers or to ecological receptors except in one area near the ASTs; subsequent soil sampling in this area indicated that contaminant concentrations were below applicable standards and remediation was not warranted. However, petroleum contamination in soils at the capillary fringe was determined to be an ongoing source of contamination to groundwater. Three alternatives were evaluated: no action, institutional controls, and biosparging with off-gas collection and treatment. The focused feasibility study concluded that only the biosparging alternative would achieve the remedial action objectives. The groundwater media was not directly assessed in the focused feasibility study.

4.6.3.1 <u>Remedy Selection and Implementation</u>

A ROD was signed on 30 September 1998 (AFCEE 1998) which documented the decision to perform a remedial action at PFSA. The selected remedial alternative was biosparging with off-gas collection and treatment to remediate the COCs ethylbenzene and total xylenes in soil. The selected remedial alternative for PFSA included the following components:

- Performance of baseline ambient air monitoring
- Collecting confirmation soil samples to refine the horizontal and vertical delineation of the target contaminants ethylbenzene and total xylenes
- Designing and installing a full-scale biosparging treatment system with off-gas collection and treatment for areas with capillary-fringe contamination
- Designing and installing a bioventing system for areas with shallow vadose zone contamination
- Collecting ambient air samples to assess compliance with ARARs
- Maintaining institutional controls that restrict site access and limit potential human exposure to contaminants

The presence of the COCs in soil could result in an unacceptable risk to those who drink groundwater at or downgradient of the PFSA source area. Therefore, the MMR-specific STCLs established for the DSRP (AFCEE 1996) were retained as RALs for the identified COCs (i.e., ethylbenzene and total xylenes). Specifically, the RAO for the PFSA as presented in the ROD is:

- Prevent organic compounds in soils from being a source of groundwater contamination.

The RALs for ethylbenzene and total xylenes in soil were established as 700 µg/kg, and 10,000 µg/kg, respectively (AFCEE 1998).

A BSVR treatment system began operation in October 2001. The system consists of a mechanical building and a wellfield. The mechanical building contains a central processing unit, air compressor, regenerative blower, moisture separator, heat exchanger, two 500-lb GAC vessels positioned in series, and a condensate-holding tank. The wellfield includes a total of 54 biosparge wells, 22 nested monitoring/observation wells, and 29 extraction wells separated into six zones which encompass both areas of capillary fringe contamination (e.g., the Western Capillary Zone and the Eastern Capillary Zone). Soil vapor extraction wells were installed to a depth of approximately 30 ft bgs and have a 10-ft screened interval. Biosparge wells were installed to a depth ranging from 60 to 70 ft bgs and have a 2-ft screened interval.

For design optimization purposes, several subsurface soil and groundwater sampling events were completed within the PFSA. Samples were analyzed for VOCs including the ROD COCs ethylbenzene and total xylenes. Samples were also analyzed for EPH/VPH by the MassDEP Method although the EPH and VPH carbon ranges were not identified as COCs in the ROD. A summary of these optimization efforts follows:

2005 Western Capillary Zone Soil Sampling and shutdown of BSVR system Zones 1 and 2: Fourteen borings were installed in 2005 and soil samples were collected to provide data to support the shut down the Western Capillary Zone of the BSVR system (AFCEE 2005, 2007). Total xylenes and ethylbenzene were not detected above the ROD RALs or MCP S-3/GW-1 standards; however, C_5-C_8 aliphatic hydrocarbons (under the MassDEP VPH Method) were detected at concentrations above the MCP Method 1 S-3/GW-1 standard at one location. In December 2005 Zones 1 and 2 of the BSVR system were shutdown with regulatory concurrence.

2006 Western Capillary Zone Soil Sampling: Soil samples were collected at 12 locations in 2006 (AFCEE 2008c). Ethylbenzene and total xylenes were not detected at concentrations above the ROD RALs. However C_9-C_{10} aromatics (VPH), C_5-C_8 aliphatics (VPH) and C_{11}-C_{22} aromatics (EPH) were detected above MCP Method 1 S-3/GW-1 standards.

2007 Eastern Capillary Zone Soil Sampling: Soil samples were collected at 23 locations in the Eastern Capillary zone of the BSVR system in 2007 (AFCEE 2008a). Ethylbenzene and total xylenes were detected at concentrations above the RALs (but at concentrations below the MCP Method 1 S-3/GW-1 soil standards) and C_9-C_{10} aromatic (VPH) and C_5-C_8 aliphatic (VPH) hydrocarbons were detected at concentrations above the MCP S-3/GW-1 standards.

Groundwater Monitoring (2005-2007): Although the groundwater media was not directly addressed in the ROD, groundwater monitoring at PFSA was conducted to assess the progress of the remedial action. Groundwater sampling was completed at PFSA in 2005 and 2007 (AFCEE 2008d). Samples were submitted for VOC analysis by EPA method

8260B and EPH/VPH analysis by the MassDEP method. No ethylbenzene or total xylenes were detected in groundwater at concentrations above the MCP Method 1 GW-1 standards. However, the C_5-C_8 aliphatics (VPH), C_9-C_{10} aromatic (VPH), and C_{11}-C_{22} aromatic (EPH) carbon ranges were detected at concentrations above the MCP Method 1 GW-1 groundwater standards. Additional groundwater sampling was completed at PFSA during this Five Year Review period in 2009, 2010, and 2011 which is discussed in Section 4.6.5.1.

In February 2008, the soil vapor recovery portion of the BSVR system was completely shut down due to low or negligible petroleum concentrations in the influent air samples. Between November 2008 and April 2010, the sparging portion of the system for select zones continued to operate to enhance aerobic degradation of the remaining petroleum compounds. Based on a review of both soil and groundwater data, it was determined that the intent of the remedy had been met and although ethylbenzene and total xylene concentrations in soil remained above the RALs, the soils were not acting as a continuing source of contamination to groundwater and the sparging system was shut down in April 2010 (AFCEE 2012b).

4.6.3.2 <u>Remedy Operations & Maintenance</u>

Operational changes to the BSVR system prior to shut down were made based on annual evaluation of data including: (1) concentrations of organics in the influent, (2) subsurface soil sampling for petroleum-related compounds, and (3) groundwater sampling results for petroleum-related compounds. Operations and sampling were documented in annual reports (AFCEE 2005, 2007, 2008c, 2008a) and the draft Interim RAR (AFCEE 2012b).

4.6.4 Progress Since Last Five Year Review

Per the EPA guidance document (EPA 2001), this section summarizes the progress made on the specific recommendations and follow-up actions presented in the prior third CERCLA Five Year Review (AFCEE 2008b). For the PFSA source area, the recommendations and follow-up actions were:

1) Determine nature and extent of EPH/VPH contamination at PFSA/FS-10/FS-11.

2) Continue operating biosparging component and collect more data to address EPH/VPH contamination at PFSA/FS-10/FS-11.

Progress since the last Five Year Review against these recommendations is as follows:

1) Soil sampling to determine the extent of the remaining petroleum hydrocarbon contamination at PFSA has been conducted since the last Five Year Review as described in Sections 4.6.3.1. In summary, operation of the BSVR system from 2001 to 2010 reduced concentrations of the ROD COCs ethylbenzene and total xylenes in PFSA soil to below the ROD RALs across most of the area. However, based on the most recent sampling results described in Section 4.6.3.1, at some locations ethylbenzene and total xylenes remain in subsurface soils at concentrations above ROD cleanup goals; and at select locations EPH/VPH carbon ranges remain in soils at concentrations above the MCP Method 1 S-3/GW-1 standards.

2) Components of the BSVR system ran through a portion of this Five Year Review period. Based on an evaluation of system performance monitoring data, the soil vapor recovery portion of the BSVR system was shut down in February 2008 due to low or negligible petroleum concentrations in the influent air samples. In April 2010, AFCEE notified the regulatory agencies that the sparging system was shutdown and there was no technical disagreement from the regulatory agencies (AFCEE 2010).

4.6.5 Five Year Review Process

4.6.5.1 <u>Data Review</u>

Three groundwater sampling events at up to 17 monitoring wells were completed at PFSA between 2009 and 2011. Groundwater samples were submitted for analysis of VOCs (including the TMB isomers) and EPH/VPH using MassDEP methods. The locations of the monitoring wells sampled are shown on **Figure 4-6** and the resulting

analytical data are summarized in **Table 4-3**. Of the 17 wells sampled during these events, petroleum-related compounds were detected at concentrations above groundwater standards (MCLs, MCP Method 1 GW-1 standards, or a RBC of 17 µg/L developed for TMBs at FS-13 [see Section 5.10]) in nine of the monitoring wells.

No ethylbenzene or total xylenes were detected in groundwater at concentrations above their respective MCLs suggesting the operation of the BSVR system has been effective in achieving its goal of reducing concentrations of the PFSA soil COCs to levels that do not act as a continuing source of groundwater contamination. However, C_5-C_8 aliphatics (VPH), C_9-C_{10} aromatics (VPH), C_9-C_{12} aliphatics (VPH), and C_{11}-C_{22} aromatic (EPH) carbon ranges continue to be detected in PFSA groundwater at concentrations greater than the MCP Method 1 GW-1 groundwater standards. In addition, the TMB isomers and 2-methynapthalene were reported at concentrations above the standards presented in **Table 4-3** at multiple locations. The PAH benzo(a)pyrene was detected at one location slightly above the MCP Method 1 GW-1 standard.

4.6.5.2 Site Inspections

An SI was completed for PFSA on 10 July 2013. The SI form is included in **Appendix B**. Since the active component of the remedial action conducted at PFSA is complete and no ongoing O&M of remedial systems is occurring, the focus of the SI was to assess general site conditions and to determine whether the land use assumptions are still valid and do not affect protectiveness. Based on the SI, land use at the site remains consistent with the assumptions used in the risk assessment and no concerns regarding protectiveness were identified.

4.6.5.3 Interviews

Refer to Section 3.6.

4.6.6 Technical Assessment

The technical assessment component of the Five Year Review consists of evaluating the protectiveness of the remedial action. AFCEC performed the technical assessment based on EPA guidance provided in Section 4.0 of the Comprehensive Five Year Review Guidance (EPA 2001).

4.6.6.1 Question A: Is the remedy functioning as intended by the decision document?

The BSVR treatment system has mitigated impact to groundwater from the COCs identified in the ROD. Although ethylbenzene and total xylenes were detected in soil at concentrations greater than the STCLs in four of 23 locations sampled in 2007, concentrations of ethylbenzene and total xylenes in groundwater are all below MCLs based on multiple rounds of sampling. The BSVR system was shut down in 2010 since continued operation would not contribute further to site cleanup. However, the post-ROD contaminants EPH/VPH continue to be detected in subsurface soil and groundwater above MCP Method 1 standards; and the TMB isomers and 2-methynapthalene have also been recently detected above groundwater standards. Monitoring data suggest that this contamination may be degrading and significant migration of the groundwater is not occurring; however, exceedances of standards have recently been reported at one off-base monitoring well so groundwater contamination has moved beyond the base boundary. No active private or municipal wells are located on this off-base property which is protected open space located in the Town of Mashpee. The Mashpee BOH has regulations in place that prohibit the use of existing and future private residential wells located in documented or anticipated areas of groundwater contamination. Therefore, potential exposure pathways to this off-base groundwater contamination are controlled through existing municipal regulations. Current on-base land use management procedures and the flightline security measures which include fencing and 24-hour security effectively limit potential human exposure to the site contaminants located on-base. The remedy presented in the ROD did not directly address groundwater contamination.

4.6.6.2 Question B: Are the exposure assumptions, toxicity data, cleanup level, and RAOs used at the time of remedy selection (current) still valid?

Changes in Standards and To-Be Considered: There have been changes in MassDEP standards for soil; however, the ROD soil cleanup levels for ethylbenzene and total xylenes are much more stringent (i.e., less than the MCP Method 1 S-1 standards).

Changes in Exposure Pathways: There have been no changes to exposure pathways or land use of the site that would affect the protectiveness of the remedy. However, the groundwater media was not directly considered at the time of remedy selection, therefore the groundwater exposure pathway should be further evaluated based on the recent history of groundwater monitoring data.

Since the VI exposure pathway was not considered during the RI, a screening evaluation of the VI pathway was completed at PFSA for both soil and groundwater (AFCEE 2012a). The VI evaluation concluded that while remediation has substantially improved site conditions, remedial actions were not designed to address VI risks, and VI risks cannot be ruled out based on an evaluation of existing data for the following primary reasons:

- Groundwater contaminant concentrations exceed groundwater-to-indoor-air VI screening values within approximately 100 ft of Buildings 561 and 587.
- Volatile compounds remain in soil within approximately 100 ft of Buildings 561 and 587.

Due to source control measures undertaken at the PFSA, volatile compound concentrations have likely attenuated further since the time the soil, groundwater, and vapor samples discussed above were collected. Additionally, it is recognized that the remaining volatile compounds are primarily petroleum-based and related vapors are expected to readily biodegrade in the subsurface as potential vapors migrate from the capillary zone (approximately 50 ft below grade) through the unsaturated zone to the existing buildings. However, based on the preliminary screening, VI risk above target levels could not be ruled out at PFSA and additional VI evaluation is recommended

following guidance that is being developed specifically for petroleum release sites like PFSA and more thoroughly considers the role of biodegradation.

Changes in Toxicity and Other Contaminant Characteristics: There were no changes in toxicity and other contaminant characteristics.

Changes in Risk Assessment Methods: There were no changes in risk assessment methodology.

Review of RAOs: RAOs need to be developed to address the petroleum hydrocarbon contamination identified in groundwater post-ROD.

4.6.6.3 Question C: Has any other information come to light that could call into question the protectiveness of the remedy?

There is no other information at this time that calls into question the short-term protectiveness of the remedy based on current land use. The PFSA site is located within installation boundaries (and a portion within the flightline area) and exposure to on-base soil and groundwater is currently controlled or mitigated by DoD land use and management practices. Although monitoring data confirms groundwater contamination is located a short distance off-base, a complete exposure pathway does not exist that questions the short-term protectiveness of the remedy. In addition, municipal regulations are in place controlling the off-base use of current and future private wells.

The petroleum hydrocarbon contamination (e.g., EPH/VPH, TMB isomers, and 2-methylnapthalene) that has been identified in groundwater above groundwater standards and/or RBCs (**Table 4-3**) requires that further remedial actions are necessary since RAOs directly related to groundwater are not included in the ROD.

4.6.7 Issues, Recommendations, and Follow-Up Actions

Establish an interim LTM program that would be designed to monitor PFSA groundwater contamination (similar to the approach followed at FTA-2 described in Section 4.4). A focused feasibility study to assess remedial alternatives for PFSA groundwater should be developed. The focused feasibility study will include an updated conceptual exposure model and RAOs addressing the groundwater media for the petroleum-related compounds. AFCEC's preferred remedy for groundwater will be presented in a proposed plan available for public review and comment. The selected remedy will be documented in an amendment to the existing ROD (AFCEE 1998). A component of the remedy for PFSA groundwater should include enforceable LUCs to ensure long-term protectiveness similar to the other IRP groundwater sites (see Section 5.0). Future Five Year Reviews should include assessment of both the PFSA source area and PFSA groundwater.

VI risks could not be ruled out during the VI screening assessment (AFCEE 2012a). It is recommended that VI be re-screened utilizing guidance being developed for petroleum release sites by EPA including the *OSWER Final Guidance for Assessing and Mitigating the Vapor Intrusion Pathway from Subsurface Sources to Indoor Air* (Final VI Guidance) and *Guidance for Addressing Petroleum Vapor at Leaking Underground Storage Tanks Sites* (Petroleum VI Guidance), both released for external review in 2013 and due to be released final soon.

4.6.8 Protectiveness Statement

The remedy for the PFSA source area is protective of human health and the environment in the short-term under the current land use scenario. The remedy is protective in the short-term since access to the site is controlled by current flight line security measures which include fencing and 24-hour security that effectively limits potential human exposure to site contaminants. Although groundwater contamination has been detected off-base, no private or municipal wells exist in the area and recent monitoring data indicate the contamination is not migrating any significant distance off base and municipal regulations are in place controlling exposure. For the remedy to be

protective in the long-term, it is recommended that additional remedial actions be implemented to address petroleum-related contamination in groundwater that was not directly addressed by the selected remedy presented in the ROD.

4.6.9 References

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4.7 STORM DRAIN-4 (SD-4)

SD-4 is a wooded drainage basin located in the southeastern section of the MMR on the eastern side of the flightline security area (**Figures 1-2** and **4-7**). The drainage basin, which became operational in 1950, received stormwater drainage from storm sewers that lead from Hangars 124, 126 (now demolished), 128, and 158 including the buildings, runways, ramps, and decks that serve these four hangars. Stormwater from the area of the former Building 123 pump house (now demolished) was also directed to the SD-4 drainage basin. In addition to stormwater runoff, the drainage basin also reportedly received flow from numerous spills and liquids disposal during daily operations at these facilities (ANG 1992, 1993). SD-4 has historically been broken into the upgradient study area, primarily within MMR and the downgradient area just north and hydraulically upgradient of Johns Pond (see Figure 2-1 in **Appendix C**). Environmental concerns remain only at the on-base portion of SD-4 within the current SD-4 source area boundary which is shown on **Figure 4-7**.

4.7.1 Site Chronology

1955 - 1970: Hangar 128 was used to maintain 18 to 21 aircraft. During that time, solvents were released into the storm drain system.

1968: An oil water separator associated with the storm drain was constructed to the north of the current source area boundary (**Figure 4-7**).

1978 -1988: Hangar 126 was used by the USCG for aircraft maintenance. Periodic heating of the wing tanks of the aircraft resulted in numerous spills of AVGAS to the hangar deck; a portion of it was washed into the storm drain system.

1978: A spill of approximately 1,000 gallons of AVGAS occurred outside of Hangar 126; it was also flushed into the storm drain system.

1989 - 1991: An SI and a supplemental SI were performed to characterize the nature and distribution of sediment, soil, and groundwater contamination (ANG 1992 and 1993).

1993 - 1994: An RI was performed to characterize the nature and distribution of sediment, soil, surface-water, and groundwater contamination and evaluate site risks (ANG 1996).

1997-1998: Completion of a feasibility study (AFCEE 1997) and a ROD (AFCEE 1998).

1999: As a pre-excavation sampling event, soil sampling was conducted in the drainage ditch north of Reilly Road (area near former Building 123) to confirm the presence or absence of TPH contamination in soils at levels above STCLs. Concurrently, surface-water and sediment samples were collected at the pond/wetland area south of Reilly Road (AFCEE 2000a) that is located within the current SD-4 source area boundary as shown on Figure 4-7.

2001–2002: Additional surface water and sediment sampling was conducted in the pond/wetland structure south of Reilly Road to provide the data necessary to complete an ecological evaluation (AFCEE 2002).

2002–2003: Both a screening-level ERA (AFCEE 2003b) and comprehensive ERA (AFCEE 2003a) were conducted to evaluate potential risks posed by inorganic constituents in hydric soils at the SD-4 pond/wetland structure south of Reilly Road.

2009: A groundwater sampling event was performed to determine whether or not residual concentrations of isomers of TMB remain in groundwater immediately downgradient from the former location of Building 123 pump house and associated USTs (AFCEE 2009).

2012: Supplemental sediment sampling was completed at the pond/wetland structure south of Reilly Road (results presented in Section 4.7.5.1).

2013: Preparation of an ESD to establish updated RALs (AFCEC 2013).

4.7.2 Background

4.7.2.1 History of Contamination

The primary environmental concerns at SD-4 were the effects of oil and hazardous material releases on surface soil, subsurface soil, surface water, and groundwater that originated from activities at the flightline buildings and were conveyed to SD-4 via the stormwater drainage system.

From 1955 to 1970, Hangar 128 was used to maintain 18 to 21 aircraft. During that time, known quantities of solvents were released into the storm drain system. From 1978 to 1988, the hangar was used by the USCG for aircraft maintenance. Periodic heating of the wing tanks of the aircraft resulted in numerous spills of AVGAS to the hangar deck; a portion of it was washed into the storm drain system. In 1978, a spill of approximately 1,000 gallons of AVGAS occurred outside the hangar; it was also flushed into the storm drain system. The nature and extent of these individual spills were investigated as part of the SI for CS-4 (USCG) and FS-1 (USCG), which are located northwest of SD-4 (ANG 1992).

It was estimated that approximately 0.5 to 1.4 million gallons of petroleum distillate solvents were released to the SD-4 stormwater drainage system. These solvents were used in daily operations at support shops located in the hangars and were reportedly dumped into hangar deck drains connected to the stormwater drainage system (ANG 1992).

4.7.2.2 Physical Characteristics, Land and Resource Use

Environmental concerns remain only at the on-base portion of SD-4 within the current SD-4 source area boundary which is shown on Figure 4-7. With the exception of the northwest corner of the SD-4 source area where a cleared area exists around the perimeter fence, the area is generally vegetated, undeveloped, and contains a densely vegetated and difficult to access pond/wetland. The SD-4 source area occupies approximately 3.7 acres and is located outside of the flightline boundary and base perimeter fence; however, the

majority of the source area including the area containing residual contamination is located within the base boundary on base property. The minimum and maximum ground surface elevations within the source area boundary are 70 ft msl and 94 ft msl, respectively. The area is expected to be maintained as open-space in the foreseeable future.

4.7.2.3 Initial Response

The pump house at former Building 123 served four 25,000-gallon USTs that were used to store JP-4 jet fuel. The former locations of these USTs are shown on Figure 3-1 in Appendix C. The building and associated USTs were removed in April 1993 along with 70 cubic yards of contaminated soil (Metcalf & Eddy 1993). In addition, trenching was performed to expose and remove fuel lines leading to the jet fueling area. Screening results did not indicate the presence of fuel-contaminated soil in fuel line trenches.

4.7.2.4 Basis for Taking Action

The basis for taking action at the SD-4 source area was as follows based on the results of the risk assessment presented in the RI:

Human Health Risk

For groundwater, the calculated cancer risks for future residents exceeded the EPA target risk range and the calculated non-cancer HI of 1.0. The primary contributors to the calculated cancer risk were beryllium and arsenic in groundwater. Both beryllium and arsenic concentrations were below their respective MCLs. The primary contributors to the calculated HI were both isomers of TMB and Mn. MCLs were not available for these constituents (ANG 1996).

For pond surface water, the human health PRA calculated cancer risks for future residents exceeded the EPA target risk range and the calculated noncancer HI of 1.0. The primary contributors to the calculated risks were PAHs, dieldrin, and Arochlor-1260. However, the calculated risks were considered conservative because of the following factors:

(1) all detected PAHs were assumed to be site-related, (2) the use of conservative exposure assumptions, and (3) the use of oral slope factors to evaluate dermal risks.

Ecological Risks

The ecological risk-based COCs identified for sediments at SD-4 included PAHs, VOCs, pesticides, PCBs, and metals. The ecological risk-based COCs identified for pond surface water at SD-4 included PAHs, pesticides, Aroclor 1260, and metals. The results of the ecological risk assessment triggered the need for an evaluation of remedial alternatives.

4.7.3 Remedial Actions

This section presents the regulatory actions, RAOs, a description of the selected remedy, and a summary of the remedy implementation at SD-4.

4.7.3.1 Remedy Selection and Implementation

Record of Decision: The *Record of Decision for Areas of Contamination FTA-2/LF-2, PFSA/FS-10/FS-11, SD-2/FS-6/FS-8, SD-3/FTA-3/CY-4, SD-4, and SD-5/FS-5 Source Areas* was signed on 30 September 1998 (AFCEE 1998) and was prepared to document the decision to perform remedial actions at several MMR sites including SD-4. The selected remedy for the on-base portion of SD-4 was Excavation/Asphalt Batching and institutional controls.

For the areas north of Reilly Road, the components of the remedy included pre-excavation sampling to assess the horizontal and vertical distribution of contamination exceeding the TPH STCL to identify areas that may require excavation to reduce source-area contaminant concentrations to protective levels and/or institutional and engineering controls to limit exposure to site-related contaminants in soil.

For areas south of Reilly Road, the remedy provides for additional sampling to assess the contribution of sediment contaminants to surface water contamination, the potential

bioavailability and toxicity of pond sediments, and, if necessary, removal of source area sediments exceeding cleanup criteria (to be developed based on pre-excavation studies). The risk assessment did not identify the need to cleanup groundwater at SD-4.

RAOs are site specific qualitative cleanup goals that must be achieved to meet remedial response objectives. The following RAOs were established for SD-4 (AFCEE 1998):

- Prevent human and ecological exposure to shallow (0 to 2 ft bgs) drainageway soil and sediment contaminated with TPH exceeding 500 parts per million.
- Manage pond sediments to prevent surface water contamination which present potential risks to human receptors exceeding the EPA cancer risk management range.
- Manage pond sediments to prevent surface water contamination at concentrations exceeding chronic ambient water quality criteria.

Cleanup levels are the site-specific quantitative values that will achieve RAOs. For the area north of Reilly Road, the inside-the-flightline TPH STCL (1,200 mg/kg) was selected as the cleanup level in the ROD. This STCL was amended in a 2013 ESD by incorporating the most current MCP S-1/GW-1 standards for EPH/VPH as RALs (AFCEC 2013). No cleanup levels were developed for sediment or surface water at the time the ROD was finalized.

The following elements of the remedy have been implemented:

<u>Pre-Excavation Sampling (North of Reilly Road)</u>: In August 1999, soil sampling was conducted in the drainage ditch north of Reilly Road (near former Building 123) to confirm the presence or absence of TPH contamination in soils at levels above STCLs. Surface soil samples (0-1 ft bgs) were collected at three locations; and soil samples were collected from 2.5-3 ft bgs at all six locations. All samples were analyzed for EPH/VPH following MassDEP methods. The analytical results from samples collected in this area indicated no EPH/VPH exceedances of the 1996 STCLs (AFCEE 2000a) or the MCP Method 1 Standards. As a result, no remedial action was required for the drainage ditch

north of Reilly Road. As discussed in Section 3.1.1 of **Appendix C**, these soil sampling data have been re-assessed and support UU/UE for this portion of the site.

Ecological Evaluation of the SD-4 Pond/Wetland Area South of Reilly Road (Surface Water and Sediment): Pre-excavation studies at the SD-4 pond/wetland area focused on surface water quality, on the bioavailability of inorganic contaminants, and on evaluation of pond/wetland structure and productivity to assess whether adverse effects are actually occurring and whether sediment remediation was justified (AFCEE 2002). The risk characterization indicated no or minimal adverse environmental impacts to indicator species at SD-4. It was recommended that the sediments in the SD-4 pond remain undisturbed.

Ecological Evaluation of the SD-4 Pond/Wetland Area South of Reilly Road (Wetland Hydric Soil): Because metals were detected in surface soil adjacent to the pond/wetland area, additional ecological risk assessment was planned to determine if any soil removal was needed. The ERA included several components to assess the need to perform remedial action for SD-4 soil. Key components of the ERA included: (1) revising the list of ecological COCs based on 2001 and 2003 sampling data; (2) completing of food chain analysis for terrestrial vertebrates; and (3) conducting toxicity tests for invertebrates and wetland plants. All analyses were performed following EPA Region I and MassDEP guidance. Updated toxicity values and exposure assumptions were used for calculations. The conclusions of the post-ROD ecological risk evaluation were that no further action was required for SD-4 hydric soil to be protective of ecological receptors. The ecological risk evaluation was documented in the *Final Revised Screening Level Risk Assessment* (AFCEE 2003b) and the *Final Ecological Risk Assessment Addendum* (AFCEE 2003a).

4.7.3.2 Remedy Operations & Maintenance

No ongoing operation or maintenance activities are being conducted at SD-4.

4.7.4 Progress Since Last Five Year Review

Per the EPA guidance document (EPA 2001), this section summarizes the progress made on the specific recommendations and follow-up actions presented in the prior third CERCLA Five Year Review (AFCEE 2008). For SD-4, the recommendations and follow-up actions were:

1) Conduct a reassessment of site data and current standards to determine if, based on future residential exposure, an unacceptable risk remains. In some cases, this may lead to the need to collect additional samples and/or conduct a risk assessment based on future residential exposure (using up-to-date toxicity data and exposure pathways). If this reassessment indicates that the site may still pose an unacceptable risk, then either (1) conduct additional cleanup to levels that allow for unlimited use and unrestricted exposure, or (2) issue a decision document implementing enforceable institutional controls preventing uses for which the site may still pose an unacceptable risk.

2) An RAR will be prepared to document all post-ROD actions.

3) An ESD will be prepared to document all changes to the remedy.

4) Groundwater needs to be re-evaluated to determine if an additional RAO and subsequent LUCs are required for the SD-4 area.

Progress since the last Five Year Review against these recommendations is as follows:

1) A reassessment of the site data and current standards has been completed and is presented in Appendix C. The following conclusions were reached:

   - With the exception of the SD-4 pond/wetland area (south of Reilly Road), the pre-excavation sampling and ecological assessment results all support UU/UE relative to the ESD RALs and the current MCP S-1/GW-1 standards and EPA RSLs.

   - The inorganic contaminants (i.e., arsenic, cadmium, total chromium, lead, nickel, thallium, and vanadium) detected in the pond/wetland in sediment

and/or soil samples do not meet UU/UE. Additional sediment sampling was conducted in July 2012 in this area as discussed in Section 4.7.5.1

2) An RAR has not been prepared to document all post-ROD actions; however, now that a reassessment of the site data has been completed and it has been determined that UU/UE will not be met, a RAR will be prepared.

3) An ESD was prepared that documented amendment of the TPH STCL presented in the ROD for the area inside-the-flightline by incorporating the most current MCP S-1/GW-1 standards for EPH/VPH as the RAL (AFCEC 2013). However, an ESD to document changes to the remedy has not been completed. Refer to Section 4.7.6 for the recommended path forward for the preparation of an ESD now that a reassessment of the site data has been completed and it has been determined that UU/UE has not been met.

4) Groundwater data have been re-evaluated as presented in Section 3.1.3 of **Appendix C** to this section. The re-evaluation included supplemental groundwater sampling at a temporary drive point (29BH0006 on **Figure 4-7**) in March 2009 to provide data to assess current TMB concentrations at SD-4. 1,2,4-TMB and 1,3,5-TMB were detected at 2.4 µg/L, and at a concentration below the reporting limit of 1 µg/L, respectively, at 29BH0006. These TMB detections are well below the calculated hazard equivalent concentration (HEC) (based on a hazard index equal to 1) of 17 µg/L for each TMB isomer that was developed for the FS-13 groundwater site assuming potable use of groundwater (AFCEE 2000b). As discussed in Section 5.10.6.2 (FS-13 Groundwater), toxicity information for TMBs has changed since the last Five Year Review. However, since the HEC presented in the FS-13 ROD (17 µg/L) is more stringent than the recalculated HEC using the updated toxicity information (19 µg/L), use of the value presented in the FS-13 ROD is appropriate to assess these TMB data collected at SD-4. In addition to the TMB detections, ethylbenzene was detected at a concentration below the reporting limit of 1 µg/L during the 2009 supplemental sampling event. This ethylbenzene concentration is well below the Federal and Massachusetts MCL

of 700 µg/L for ethylbenzene in drinking water. Based on a review of the groundwater data collected during the RI (ANG 1996) and these supplemental data (presented in Section 3.1.3 of Appendix C) the remedy at SD-4 does not require revision to address groundwater and RAOs for groundwater are not needed.

4.7.5 Five Year Review Process

4.7.5.1 Data Review

A comprehensive reassessment of historic site data is presented in Appendix C to this section. Appendix C also presents the results of supplemental groundwater sampling conducted in 2009 at SD-4. These actions were completed in response to recommendations presented in the last Five Year Review (AFCEE 2008).

Additional sediment characterization data were collected at SD-4 on 16 July 2012 to determine the current concentrations of the inorganic compounds detected at three sample locations (LKSD4-4, LKSD4-5, and LKSD4-6 which were originally sampled in 1999) in the SD-4 pond/wetland located south of Reilly Road. Inorganic compound concentrations in the samples collected in 1999 at these locations exceeded the 2013 ESD RALs, MCP S-1/GW-1 standards, and/or EPA RSLs. Surface soil samples were collected from the same three locations (LKSD4-4, LKSD4-5, and LKSD4-6) sampled in 1999 from approximately 0 to 0.25 ft bgs for analysis of arsenic, cadmium, total chromium, lead, nickel, and vanadium. A summary of results with a comparison to the 2013 ESD RALs, EPA RSLs and MCP Method 1 S-1/GW-1 standards is included in Table 4-4. All six inorganic compounds were present at concentrations above the lower of the screening levels considered at two of the three locations sampled (LKSD4-5 and LKSD4-6). Only arsenic and total chromium concentrations exceeded the lower of the screening levels considered at location LKSD4-4.

The basis of the arsenic, cadmium, total chromium, and nickel screening values presented in Table 4-4 is either the EPA RSLs or MCP Method 1 S-1/GW-1 standards and are

therefore human health related. The screening value for lead is the RAL presented in the 2003 ESD and adopted as an RAL for SD-4 in the 2013 ESD and is based on MassDEP background values (AFCEC 2013, AFCEE 2003c). The screening value for vanadium is the RAL presented in the 2003 ESD and adopted as an RAL for SD-4 in the 2013 ESD and is considered protective for all ecological receptors at the MMR (AFCEE 2003c). As presented in **Table 4-4**, the vanadium concentrations reported at LKSD4-5 (50 mg/kg) and LKSD4-6 (58 mg/kg) only slightly exceed the RAL of 47 mg/kg and are well below the human health based screening levels (i.e., the MCP S-1/GW standard of 600 mg/kg and EPA RSL of 390 mg/kg). As discussed in Section 4.7.3.1, the post-ROD ecological risk evaluations completed for SD-4 (AFCEE 2002, 2003a, 2003b) concluded that no further action was required to be protective of ecological receptors. These site specific ecological risk evaluations considered vanadium concentrations in soil and sediment at concentrations higher than those detected during the 2012 sampling effort. Therefore, although the recent vanadium concentrations detected in the wetland sediments exceed the RAL (which is based on an ecological screening value) vanadium concentrations in excess of the 2012 levels were previously found to be of no ecological concern.

The results of the July 2012 resampling at three sediment sample locations confirm that inorganic compounds (arsenic, cadmium, total chromium, and nickel) remain in the pond/wetland area at concentrations above human health screening levels and lead remains above background. Therefore, the data do not support UU/UE in this area. Institutional controls are required at SD-4 specifically for the pond/wetland area (south of Reilly Road) for the remedy to be protective of human health in the long-term. These institutional controls will be added to the remedy through the preparation of an ESD.

4.7.5.2 Site Inspections

An SI was completed for SD-4 on 19 June 2013. The SI form is included in **Appendix B**. Since the remedial actions conducted at SD-4 are complete and none require ongoing O&M and no formal LUCs are currently in place, the focus of the SI was to assess general site conditions and to determine whether the land use assumptions are still valid and do not affect protectiveness. Based on the SI, land use at the site remains

consistent with the assumptions used in the risk assessment and no concerns regarding protectiveness under current land use were identified.

4.7.5.3 Interviews

Refer to Section 3.6.

4.7.6 Technical Assessment

The technical assessment component of the Five Year Review consists of evaluating the protectiveness of the remedy. The technical assessment is based on EPA guidance provided in Section 4.0 of the Comprehensive Five Year Review Guidance (EPA 2001).

4.7.6.1 Question A: Is the remedy functioning as intended by the decision document?

Results of the post-ROD petroleum hydrocarbon sampling conducted at the drainage ditch north of the Reilly Road indicated that no action was necessary for the protection of human health or ecological receptors for this area designated as part of SD-4. The post-ROD ecological evaluation for the pond and associated wetland using 2001 and 2003 data, updated toxicity and exposure assumption information, and results of site-specific toxicity tests indicated that no action was necessary for the protection of ecological receptors. Updated comparison of pre-excavation and ecological assessment results all support UU/UE relative to the 2013 ESD RALs and the current MCP S-1/GW-1 standards and EPA RSLs with the exception of the pond/wetland area (south of Reilly Road) where institutional controls are required for the remedy to be protective in the long-term due to the presence of soils and sediments containing inorganic compounds at concentration exceeding screening levels. Therefore, the remedy is functioning as intended by the ROD for all areas except the pond/wetland area where institutional controls should be applied to maintain protectiveness under future land use scenarios.

4.7.6.2 Question B: Are the exposure assumptions, toxicity data, cleanup level, and RAOs used at the time of remedy selection (current) still valid?

Changes in Standards and To-Be Considered: There have been changes in standards and they have been adopted as updated RALs as documented in the 2013 ESD (AFCEC 2013). Site data has been reassessed against these updated RALs and it is concluded that UU/UE is supported for all areas except the pond/wetland area (south of Reilly Road) where institutional controls are required to maintain protectiveness in the long-term.

Changes in Exposure Pathways: There have been no changes in the physical conditions and exposure pathways of the site that would affect the protectiveness of the remedy. Due to added concern related to the VI exposure pathway, a VI screening assessment has been conducted for a number of release sites at the MMR (AFCEE 2012) but not SD-4. VI exposure pathway screening should be completed at SD-4 since residual VOCs and EPH/VPH detections do remain in soil and groundwater although at concentrations below UU/UE screening levels for the exposure pathways considered.

Changes in Toxicity and Other Contaminant Characteristics: There were changes in the toxicity factors for the SD-4 COCs and they were taken into account during the establishment of the updated RALs presented in the 2013 ESD (AFCEC 2013).

Changes in Risk Assessment Methods: None.

Review of RAOs: Updated comparison of pre-excavation and ecological assessment results all support UU/UE relative to the 2013 ESD RALs and the current MCP S-1/GW-1 standards and EPA RSLs with the exception of the pond/wetland area (south of Reilly Road) where institutional controls are required to maintain protectiveness in the long-term. The RAOs should be revised based on the findings of this re-assessment of the site data through the preparation of an ESD.

Based on supplemental groundwater sampling completed in 2009 and a review of groundwater data collected during the RI (ANG 1996), RAOs for SD-4 groundwater are not needed.

4.7.6.3 Question C: Has any other information come to light that could call into question the protectiveness of the remedy?

There is no information at this time that calls into question the short-term protectiveness of the remedy for SD-4 based on current land use including the presence of the inorganic compounds that remain in soils and sediment in the pond/wetland area south of Reilly Road. The portion of the SD-4 site where UU/UE conditions have not been met is located within installation boundaries but outside the perimeter fence. Exposure pathways for humans are currently mitigated by the remoteness and nature of the site (i.e., heavily vegetated wetland).

4.7.7 Issues, Recommendations, and Follow-Up Actions

The following are recommendations and follow-up actions:

(1) An RAR, in accordance with *Close Out Procedures for National Priority List Sites*, OSWER Directive 9320.2-22 (EPA 2011), will be developed to document post-ROD actions completed at SD-4, providing the basis for implementation of institutional controls to prevent uses posing unacceptable risk under a future use scenario at the pond/wetland area south of Reilly Road.

(2) An ESD will be prepared to document the no further action decision based on post-ROD sampling and ecological risk analyses for current and future use for all areas except the pond/wetland area (south of Reilly Road) where institutional controls are required for the remedy to be protective in the long-term due to the presence of soils and sediments containing inorganic compounds at concentrations exceeding screening levels for unrestricted use. The ESD will also update the RAOs based on the findings of the re-assessment of data presented in **Appendix C** and Section 4.7.5.1.

(3) The VI exposure pathway should be assessed at SD-4. It is recommended that the site be screened utilizing applicable EPA guidance including the OSWER *Guidance for Assessing and Mitigating the Vapor Intrusion Pathway from Subsurface Sources to Indoor Air* and *Guidance for Addressing Petroleum Vapor*

at Leaking Underground Storage Tanks Sites, which have both been released for external review in 2013 and are due to be released final by the end of 2013.

4.7.8 Protectiveness Statement

The remedy for the SD-4 source area is protective of human health and the environment in the short-term under the current land use scenario. Site data has been reassessed against updated RALs with the finding that UU/UE is supported for the majority of the SD-4 site. However, concentrations of inorganic compounds remain in soil and sediment above the updated RALs in the pond/wetland area (south of Reilly Road) and UU/UE conditions have not been met based on these data. This portion of the SD-4 site is located within installation boundaries and access to the area is unlikely due to its remoteness and nature (heavily vegetated wetland). However, institutional controls preventing uses for which the site may still pose an unacceptable risk should be implemented to ensure long-term protectiveness.

4.7.9 References

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5.0 GROUNDWATER SITES REQUIRING FIVE YEAR REVIEW

This section presents groundwater sites for which a Five Year Review is required. Fourteen groundwater sites (**Table 1-3**) required a Five Year Review because of one of the following conditions:

- the remedy was in place at the start of this Five Year Review period and the site is in Remedial Action – Operation status; or
- the remedy decision was completed during this Five Year Review period (i.e., between 2007 and 2012), the remedy is in place, and the site is in Remedial Action – Operation status.

5.1 ASHUMET VALLEY (AV) GROUNDWATER

The AV plume is a dissolved-phase groundwater plume (**Figure 5-1A**) that is defined by the extent of groundwater containing the AV COCs PCE and TCE at concentrations exceeding the federal MCL of 5 µg/L for each compound. In addition, thallium and Mn are COCs at AV but are not used to define the extent of the AV plume. The cleanup level for thallium is the MCL of 2 µg/L; the cleanup level for Mn is the EPA Health Advisory (HA) of 300 µg/L. Thallium and Mn detections, which are limited to an area immediately downgradient of the former source areas and to the west of Ashumet Pond, are expected to decrease to concentrations below cleanup levels without active treatment.

5.1.1 Site Chronology

1979: Recognition of the AV plume began when the Massachusetts Department of Environmental Quality Engineering (DEQE, now MassDEP) ordered the Town of Falmouth to shut down a municipal well due to levels of methylene-blue-active-substances (detergents) detected during a U.S. Geological Survey (USGS) investigation that exceeded generally accepted standards at that time (AFCEE 2009a). This municipal water supply well is located near the western edge of the current plume boundary in the central zone approximately 300 ft east of Sandwich Road and approximately 1,500 ft south of Ashumet Road (**Figure 5-1A**).

1983: During a records search conducted for the MMR, FTA-1 was identified as a potentially hazardous site and a sewage plume associated with the MMR sewage treatment plant (STP) (later referred to as CS-16/CS-17) was first characterized by the USGS in a number of studies during the 1980s (AFCEE 2009a).

Late 1980s - 1995: A detailed assessment of the migration of the plume and the potential risks to downgradient receptors was performed in the late 1980s and 1990. Additional RIs were conducted to address soil and groundwater contamination emanating from FTA-1 and CS-16/CS-17. The first RI report was completed in the late 1980s, with additional work completed in 1991 (ABB 1991). This investigative work was updated in November 1994, with an additional RI report completed in 1995 (ABB 1995).

<u>1994-1995</u>: The NGB, DoD, EPA, MassDEP, and local communities approved a Plume Response Plan that presented an accelerated effort toward "simultaneous containment" of seven groundwater plumes including AV. An Interim ROD (IROD) for the seven groundwater plumes emanating from the MMR was signed on 25 September 1995 (ANG 1995). The IROD stated that groundwater extraction and treatment systems should be designed, installed, and operated until a final remedy for the site is chosen. For AV, the interim remedy consisted of extraction, treatment, and infiltration (ETI) technology to achieve a significant degree of plume capture.

<u>1999</u>: Completion of the final wellfield design for the AV VOC plume which consisted of three extraction wells, two treatment plants, and two infiltration trenches (AFCEE 1999). This ETI system was installed in 1999 under the IROD.

<u>2006</u>: Optimization of the ETI system resulting in discontinuing the operation of two of the three ETI system extraction wells and shutdown of one of the two treatment plants (AFCEE 2007b).

<u>2007</u>: Completion of a feasibility study (AFCEE 2007c) and proposed plan (AFCEE 2007a) for Ashumet Valley groundwater.

<u>2009</u>: Preparation of the final ROD for AV groundwater (AFCEE 2009a). As part of the final remedy and as described in the ROD, the IROD ETI system was expanded in 2009 by adding additional treatment for the southern portion of the plume. The expansion included one additional extraction well, a mobile treatment unit (MTU) for GAC treatment, and a bubbler in the Backus River for the discharge of the treated water. Remedy in place was achieved in 2009 with the startup of the leading edge system (AFCEE 2010a).

<u>2011</u>: An ESD was prepared that clarified the inclusion of MNA as a component of the selected remedy and added text regarding the MMR three-step process to achieve site closure (AFCEE 2011a).

5.1.2 Background

5.1.2.1 History of Contamination

Firefighter-training exercises were held from 1958 to 1985 at FTA-1, during which time flammable waste liquids (e.g., VOCs) were burned and extinguished. Additionally, the former MMR STP, which operated from 1936 to 1995, released treated wastewater to a series of sand infiltration beds (CS-16) while de-watered sewage sludge was disposed of in a nearby wooded area (CS-17). These two practices and locations (FTA-1 and MMR STP) are considered to be the sources of contaminants that have resulted in the AV groundwater plume (**Figure 5-1A**). In addition, a phosphate plume, which originated from the discharge of treated wastewater from the MMR STP, is located near the northwest shore of Ashumet Pond; this phosphate plume is being addressed by AFCEC but not under a CERCLA action.

The source of the thallium and Mn detected in groundwater is believed to be the native aquifer materials where these compounds are naturally present. The discharge of treated wastewater from the MMR STP created reducing conditions in the aquifer that led to dissolved concentrations of these compounds above background levels and established cleanup standards. These concentrations are expected to decrease to background levels as the aquifer becomes re-oxygenated over time and the effects on groundwater quality due to the discharge from the STP diminish (AFCEE 2012d).

5.1.2.2 Physical Characteristics, Land and Resource Use

Based on the most recent groundwater monitoring data collected in 2011, the AV plume consists of three disconnected zones of contamination. The northernmost zone is approximately 3,500 ft long and 700 ft wide; the central zone is approximately 3,400 ft long and 1,100 ft wide; and the southern zone is approximately 9,000 ft long and 2,250 ft wide. The plume ranges up to 75 ft thick in the aquifer. The plan view extent of the AV plume is shown on **Figure 5-1A**. The footprint of the AV plume was approximately 830 acres in 2007 and approximately 487 acres in 2012. **Figure 5-1A** also identifies the area where Mn concentrations remain above cleanup levels and LTM is underway.

Sampling completed in 2011 in this area where thallium and Mn are COCs indicated that thallium concentrations no longer remain above the MCL of 2 µg/L. However, Mn concentrations do remain above the EPA HA of 300 µg/L in this area (AFCEE 2012d).

Land above the AV plume is used for residential, limited commercial/industrial, agricultural, and recreational purposes including golf courses, and a wildlife area managed by the Massachusetts Division of Fisheries and Wildlife (MDFW) (Crane Wildlife Management Area [CWMA]). Agricultural use of land in the area of the plume is primarily in the south with the cultivation and harvesting of cranberries from the Backus River bogs (**Figure 5-1A**). The land above the AV plume can be characterized as a broad, flat, gently southward sloping glacial outwash plain. Within the footprint of the plume, the maximum and minimum ground surface elevations are 84 ft msl and 10 ft msl, respectively.

5.1.2.3 Initial Responses

A summary of the initial responses is as follows:

Non- CERCLA Actions

MMR STP Upgrade Program: The ANG upgraded the STP to discharge effluent to new sand filter beds near the Cape Cod Canal to the north of the MMR. Demolition of the former STP concrete structures was completed in 1997. Remaining sludge in the tanks was removed and treated in 1996 before demolition.

1998: The AV interim remedy originally included an extraction fence on the shore of Ashumet Pond to mitigate the discharge of groundwater containing phosphate that originated from the former STP infiltration beds to the surface water of Ashumet Pond. Subsequent to the interim decision that was made in September 1997, additional data and analysis suggested that an extraction fence to protect Ashumet Pond from phosphate may not be the most effective or beneficial approach and could result in detrimental effects on pond health. AFCEE, in conjunction with the Technical Review and Evaluation Team (TRET), a prior technical and community advisory panel, convened several forums in

which local and state experts in phosphate transport and phosphate remediation evaluated uncertainties concerning phosphate mobility, its effect on pond ecology, and potential implications for the overall remedial strategy for the AV plume. The following general conclusions were drawn from these meetings:

- An extraction, treatment, and reinjection (ETR) approach is very inefficient given that phosphate is largely bound (or adsorbed) to the aquifer media;
- USGS bench-scale and field scale tests (e.g., clean water injections) indicate that an operating ETR system may result in overall increases in phosphate loading to the pond rather than reductions;
- No imminent threat or emergency exists since aquifer/pond data collected over the six years prior to these meetings indicate that a steady state exists (i.e., phosphate concentrations in groundwater at wells near the pond have not changed).

Based on these conclusions, AFCEE recommended a revised approach for phosphate that did not include an extraction fence.

<u>2001-2012</u>: AFCEE implemented a three-pronged approach to address the phosphate associated with the STP. The first element was an in-pond alum treatment to bind phosphate that had built up in the deep, anoxic portion of Ashumet Pond. This alum treatment was conducted in September 2001 and resulted in significant reductions of phosphate available for spring and fall algae blooms. The second element involves continued monitoring of surface water quality parameters to assess the health of the pond. The third element was the installation of a geochemical barrier at the plume-pond interface on the northwest shore of Ashumet Pond near Fisherman's Cove in 2004. Trophic health monitoring data collected since the installation of the barrier indicate the barrier has significantly reduced the phosphate load to the pond. However, increasing phosphate concentration trends observed between 2007 and 2009 led to the need to perform a second in-pond alum treatment in September 2010. Based on post-alum treatment monitoring data collected in 2010 and 2011, it was concluded that prior increasing eutrophication has been reversed, and a steady improvement in pond trophic health is being observed. It was also noted that because total phosphate concentrations in the groundwater plume discharging to the pond are gradually decreasing with time and

the barrier is continuing to effectively reduce phosphate loading to the pond, the 2010 alum treatment may last significantly longer than the 2001 alum treatment (AFCEE 2012b). Continued surface water monitoring is planned to track the trophic health of the pond.

CERCLA Actions

The 1995 IROD, which included an interim remedy for AV, stated that extraction and treatment will continue until the final remedy for the site is chosen (ANG 1995). In summary, the interim remedy provided for:

- extracting contaminated groundwater at the leading edge of the contaminant plume and potentially extracting groundwater from hot spot areas identified during remedial design;
- pumping and conveying the extracted groundwater to a treatment system to remove contaminants;
- discharging the treated water back to the groundwater and/or other beneficial use;
- installing monitoring wells, measuring water levels, and sampling groundwater to monitor the performance of the extraction system; and
- sampling the influent and effluent of the treatment system to monitor its performance.

In addition for AV, the NGB funded two other interim remedial measures to address the impact of the AV plume and to protect the public health of local residents. The NGB reimbursed the Town of Falmouth for the cost of the water supply well that was shutdown and provided funds to extend the Falmouth municipal water system into the neighborhood north of Route 151.

The TRET, established in 1996 as part of a new IROD management process, reviewed wellfield designs and determined that the 60-percent design for containment of several of the IROD plumes would cause negative ecological impacts (TRET 1996). The proposed interim remedy for the AV groundwater plume was then revised to include the design and installation of an ETI remedial system to achieve a significant degree of plume capture. An axial extraction fence was proposed to be placed within the body of the AV plume to

capture and treat VOCs. The fence would extend from just north of Route 151 to Hayway Road (**Figure 5-1A**). To help protect Ashumet Pond, an ETR fence to capture phosphate and VOCs would be located along the northwest shore of the pond near Fisherman's Cove. Modifications to the alternative included providing funds of $8.5 million to the Town of Falmouth to address nitrate loading in surface waters near the southern leading edge of the AV plume, investigating the southeast portion of the plume between Hayway Road and Carriage Shop Road to determine if additional remediation would be required, and a decision not to install an axial fence south of Carriage Shop Road as originally planned. Under this modified alternative, AFCEE would monitor the uncaptured portion of the AV plume located to the south of Hayway Road as part of this interim remedy while additional information related to this area was gathered.

The design of an axial wellfield array removed the ETR system originally proposed near Ashumet Pond to capture the phosphate plume from the STP. The impact of the phosphate plume to Ashumet Pond was addressed in other non-CERCLA remedial actions (AFCEE 2009a). The final wellfield design (AFCEE 1999) for the AV VOC plume consisted of three extraction wells, two treatment plants, and two infiltration trenches. The ETI system was installed in 1999 under the IROD. As part of the final remedy and as described in the final ROD (AFCEE 2009a), the system was expanded in 2009 by adding additional treatment for the southern portion of the plume. The expansion included one additional extraction well, an MTU for GAC treatment, and a bubbler in the Backus River for discharge of the treated water (**Figure 5-1A**). Further details regarding the AV remedial system can be found in the 2012 O&M Plan (AFCEE 2012c).

<u>FTA-1 Source Area</u>: Remedial actions performed at the FTA-1 source area consisted of excavation and on-site thermal treatment of contaminated soil. The treatment of contaminated soils at FTA-1 began in June 1995 and was completed in September 1997. A total of 42,531 tons of soil were excavated, thermally treated, and backfilled. The *Final Closure Report for the FTA-1 Site* (AFCEE 2000) outlines the soil excavation, thermal treatment, and backfilling activities.

STP Source Area: Remedial actions at the CS-16/CS-17 source area consisted of excavation and off-site disposal of contaminated soil. The *Final Remedial Action Report Area of Contamination CS-16/CS-17* (AFCEE 2003) details the selected remedy for the CS-16/CS-17 source areas. Approximately 6,000 tons of soil were excavated for the CS-16/CS-17 source removal and disposed of off-site in fall 2001.

AV Groundwater Plume: The AV ETI system that was part of the interim remedy began operation on 22 November 1999 with three extraction wells, two treatment plants, and two infiltration trenches. The extraction wells (95EW0701, 95EW0702, and 95EW0703) are located along the axis of the plume between Route 151 and Hayway Road and were designed to extract 1,200 gallons per minute (gpm) of groundwater from the aquifer. The treatment plants are located along Sandwich Road and each house two 20,000-lb GAC vessels, arranged in series operation, to remediate the contaminated groundwater. The two infiltration trenches are aligned parallel to the long axis of the plume, each designed to return 600 gpm of treated water to the aquifer. One infiltration trench is located along Sandwich Road and the other trench is located on Currier Road (**Figure 5-1A**).

On 18 May 2007, the ETI system was optimized and the operation of the two northernmost extraction wells (95EW0701 and 95EW0702) was discontinued, having substantially remediated the aquifer within their capture zones (AFCEE 2007b). The ETI system currently operates with one extraction well (95EW0703) processing 350 gpm through one of the two treatment plants (one treatment plant was taken out of service). The treated water is returned to the aquifer via the two trenches at approximately 175 gpm each.

As part of the final remedy and as described in the final ROD (AFCEE 2009a), AFCEE expanded the remedial system by adding treatment at the leading edge of the plume. On 24 August 2009, the new leading edge treatment system began operation which consists of an extraction well (95EW0704) pumping at 175 gpm, an MTU housing a GAC system, and a discharge bubbler that returns treated water to the Backus River. In total, this new extraction, treatment, and discharge (ETD) system combined with the original ETI system are currently treating 525 gpm of contaminated groundwater.

5.1.2.4 Basis for Taking Action

Future residential exposure to the AV groundwater COCs present an excess lifetime cancer risk greater than the acceptable MassDEP threshold of 1×10^{-5} and the acceptable EPA range of 1×10^{-4} to 1×10^{-6}. For Backus River surface water, potential cancer risks and non-cancer hazards associated with recreational exposures were found to be acceptable (AFCEE 2009a).

An ecological risk assessment concluded that it is very unlikely that there are ecological risks associated with the AV groundwater plume (AFCEE 2009a).

5.1.3 Remedial Actions

The final remedy for the AV plume was determined in the *Final Record of Decision for the Ashumet Valley Groundwater* (AFCEE 2009a) which was signed on 10 June 2009. The RAOs for the AV groundwater plume (AFCEE 2009a) are as follows:

- Prevent residential exposure to AV groundwater with TCE concentrations greater than the MCL of 5 µg/L.
- Prevent residential exposure to AV groundwater with PCE concentrations greater than the MCL of 5 µg/L.
- Prevent residential exposure to groundwater located between Kittridge Road and the western shore of Ashumet Pond that has been impacted by the AV plume and that contains Mn concentrations greater than the lifetime HA of 300 µg/L.
- Prevent residential exposure to groundwater located between Kittridge Road and the western shore of Ashumet Pond that has been impacted by the AV plume and that contains thallium concentrations greater than the MCL of 2 µg/L.
- Restore usable groundwaters to their beneficial uses wherever practicable, within a timeframe that is reasonable given the particular circumstances of the site.

5.1.3.1 Remedy Selection and Implementation

The selected remedy in the ROD (AFCEE 2009a) consists of the following:

- Continued operation of the existing optimized AV ETI system (one extraction well and two associated infiltration trenches) and treatment via GAC that was installed under the interim ROD. Additionally, the final remedy included a new extraction

well installed in the southern portion of the plume to improve mass capture in that area. The additional flow from the southern extraction well is treated at an MTU using GAC in close proximity to the extraction well and discharged through a bubbler to the Backus River.

- Chemical and hydraulic monitoring of the plume under the SPEIM program, as long as active remediation continues, and chemical monitoring of the plume until the RAOs are met. The chemical monitoring program will include LTM for Mn and thallium at wells in an area west of Ashumet Pond (**Figure 5-1A**). The objective of this thallium and Mn LTM program will confirm that concentrations of these COCs are decreasing. As noted in Section 4.2, monitoring for thallium was discontinued in 2012 (AFCEE 2012d).
- Implementation of LUCs with the performance objectives of:
  - preventing access to, or use of, contaminated groundwater from the AV plume until the groundwater no longer poses an unacceptable risk, and
  - maintaining the integrity of the current or future remedial or monitoring system such as the treatment systems and monitoring wells.
- Completion of CERCLA reviews every five years throughout the lifetime of the remedial action.

Since the final remedy was selected in 2009, the following changes have occurred:

- The 2011 ESD for the IRP groundwater plumes (AFCEE 2011a) clarified the inclusion of MNA as a component of the selected remedy for AV and added text regarding the MMR three-step process to achieve site closure.

Remedial system performance monitoring data and long-term plume monitoring data collected under the SPEIM/LTM program are used to assess: (i) whether the remedial objectives and system performance metrics are being met; (ii) whether remediation is progressing as expected; and (iii) to identify and assess optimization opportunities. The data collected under the SPEIM program are presented to the regulatory agencies through the Technical Update meeting process and documented in the annual SLR.

As part of the LUC process specified in the ROD (AFCEE 2009a), a private well verification survey was completed at AV between April 2008 and June 2012. The private well verification survey completed at the AV LUC area consisted of outreach to 677 parcels. Responses were obtained from 98 percent of the property owners within the AV LUC area and identified a total of 137 properties that have one or more private wells

that are used as a non-potable water source. Two parcels were identified that have private wells that are used as a potable water supply but are outside of the AV plume footprint and are not anticipated to represent complete exposure pathways to the AV plume. Technical evaluations were completed for each private well to determine the sampling frequency and/or re-evaluation frequencies (if necessary), and those results are provided in the *Ashumet Valley Private Well Verification and Well Determination Project Note* (AFCEE 2013). No private wells that were identified present an unacceptable exposure risk from the AV groundwater. One private residential irrigation well located in the northern portion of the AV plume area will be monitored annually due to uncertainty regarding the well depth and the proximity of contamination associated with the nearby CS-10 groundwater plume (AFCEE 2013). In addition, agricultural irrigation wells located near the Backus River cranberry bogs will continue to be monitored under AFCEC's LUC Program. In the event that new private well information is obtained or plume monitoring data indicate a change to the CSM at AV, AFCEC will perform the necessary well determinations at the time the information becomes available.

In addition, between February and July 2013, AFCEC contacted the owners of private wells that were determined to be non-operational or disconnected to confirm that these wells have not been restarted. During this 2013 outreach, AFCEC determined that two of the 150 private wells that were identified during the initial well verification effort as non-operational or disconnected have been returned to service for outdoor uses. Technical evaluations were completed for both private wells and based upon a review of SPEIM data and private well sampling data there is no current risk of exposure to the AV groundwater plume through the intermittent use of these wells for outdoor purposes. The technical evaluations for the two private wells that were restarted in 2013 are included in **Appendix D**.

The status of non-operational private wells in the AV LUC area will continue to be tracked. AFCEC will distribute a mailing, on an annual basis, to property owners within the LUC area that have non-operational wells for which no technical evaluation could be completed due to a lack of known well depths and inability to sample. The intent of the

annual mailing is to remind these property owners that they should contact AFCEC for a technical evaluation, which may include sampling, in the event their well is put back into service. In addition to these annual mailings, AFCEC will perform outreach as part of future Five Year Reviews to each of the property owners requiring confirmation of the non-operational status of their wells (AFCEC 2013a).

5.1.3.2 Remedy Operation & Maintenance

The AV remedial systems are operated and maintained under an approved O&M Plan (AFCEE 2012c). The O&M Plan is updated on an annual basis and includes operational requirements, a summary of the operational history of the systems, and details of any system modifications, optimizations, or improvements. While occasional operational issues are identified, these issues have been, and continue to be, addressed in a timely and effective manner such that O&M associated with the remedy is considered effective at achieving the remedial goals. Operational issues are identified in O&M monthly reports and system performance and reliability is reported in the annual SLRs.

The annual SPEIM/LTM/O&M costs associated with ongoing remedial actions at AV are generally consistent with those predicted at the time of remedy selections (with consideration for savings associated with optimization initiatives) and do not indicate potential remedy problems.

5.1.4 Progress Since the Last Five Year Review

Per the EPA guidance document (EPA 2001), this section summarizes the progress made on the specific recommendations and follow-up actions presented in the prior third CERCLA Five Year Review (AFCEE 2008a). For the AV groundwater plume, the recommendations and follow-up actions were:

1) Section 4.1 of the third Five Year Review recommended that a screening level VI evaluation be completed for each IRP groundwater site. The objective of the VI evaluation was to determine if a VI exposure pathway exists at a particular site,

and, if so, complete a screening level evaluation to determine if VI risk above target levels is likely or unlikely.

2) Section 4.3 of the third Five Year Review recommended that, in order to ensure long term protectiveness, all groundwater sites with off-base plume areas must undergo the well verification process as described in AFCEC's guideline titled *Verification, Decommissioning, and Documentation Guidelines for Private Wells in Areas of Potential Concern* (AFCEE 2008d). It was recommended that this requirement be codified in an ESD for those off-base groundwater sites with RODs that do not currently contain the well verification language as part of the required LUCs. For off-base groundwater sites without final RODs at the time of the third Five Year Review (AV and CS-10), the well verification language should be included in the LUC requirements presented in the final RODs.

Progress since the last Five Year Review against these recommendations and follow-up actions is as follows:

1) A VI evaluation was completed for the 16 IRP groundwater sites at the MMR as documented in the *Final 2011 MMR Vapor Intrusion Evaluation Technical Memorandum* (AFCEE 2012a) including AV. The VI evaluation indicated an incomplete pathway for VI at AV and no further monitoring or data collection is needed specific to VI at AV. However, as part of the ongoing remedial actions at AV, AFCEC will continue to monitor the nature and extent of the AV plume under the SPEIM program and will re-evaluate the VI exposure pathway if conditions change such that VI could be a concern.

2) The final remedy for the AV plume was determined in the *Final Record of Decision for the Ashumet Valley Groundwater* (AFCEE 2009a) which was signed on 10 June 2009 and included the requirement to complete the private well verification portion of the LUCs within three years of the signing of the ROD. This well verification effort was completed in 2012 and concluded that no private wells that were identified present an unacceptable exposure risk from the AV

groundwater (AFCEE 2013). Further details of the well verification process and findings are included in Section 5.1.3.1.

5.1.5 Five Year Review Process

5.1.5.1 Data Review

The MMR SPEIM program was developed to monitor plume changes and to ensure the effective operation of the AFCEC groundwater remediation systems at the MMR. These objectives are met through monitoring of selected media (i.e., groundwater, surface water) within and outside the plume boundaries, treatment plant monitoring, and groundwater flow and transport modeling. The data collected under the SPEIM program are continually assessed by a team of on-site professional staff and the results of these assessments are presented to the regulatory agencies initially during Technical Update meetings and then through technical memoranda or project note deliverables, if warranted, based on the results of the data evaluation or to address particular plume issues.

In addition, AFCEC prepares annual SLRs for the groundwater plumes that are being addressed through active treatment. The purpose of these SLRs is to document the results of sampling activities conducted at each plume under the SPEIM program. The SLRs also include: (i) a summary of all major events and optimizations completed at the plume; (ii) O&M-related system performance information such as contaminant mass removal/air emissions, system flow rate summaries, and downtime summaries; and (iii) all relevant technical assessment documentation completed during the annual reporting period as attachments or by reference. The SLRs are provided to the broad stakeholder group for each plume including Federal (EPA) and State (MassDEP, MassDPH) regulatory agencies, town departments (such as the BOHs, Departments of Public Work, Water Departments, and/or Conservation Commissions), affected property owners, and other interested parties. The SLRs are publically available in the IRP Administrative Record and copies are maintained at the local town libraries.

In addition to the annual SLRs prepared for AV during this Five Year Review period (AFCEC 2013b, AFCEE 2012e, 2011b, 2010b, 2009b, 2008e), the following technical deliverables were prepared that assessed system performance or presented the results of optimization evaluations:

- *Ashumet Valley 2007 Triennial SPEIM Data Presentation and Optimization Testing Results Project Note* (AFCEE 2008b)
- *Ashumet Valley 2008 Data Gap Investigation and Plume Shell Update Project Note* (AFCEE 2008c)
- *Ashumet Valley 2009 Annual/Semiannual SPEIM Data Presentation Project Note* (AFCEE 2010c)
- *Ashumet Valley 2010 Annual/Semiannual SPEIM Data Presentation Project Note* (AFCEE 2011c)
- *Ashumet Valley 2011 Triennial/Annual SPEIM Data Presentation Project Note* (AFCEE 2012d)

While additional details are provided the documents listed above, the primary findings and conclusions from these system performance evaluations at AV are as follows:

1. The AV remedial systems removed approximately 55 lbs of PCE and TCE through the treatment of approximately 1.0 billion gallons of groundwater during this Five Year Review period. In total, the AV ETI and ETD systems have treated approximately 5.5 billion gallons of contaminated groundwater and removed approximately 337 lbs of PCE and TCE since system startup through December 2012.

2. A comparison of the AV plume boundary at the start and end of this Five Year Review period (i.e., 2007 versus 2012) is included on **Figure 5-1B**. PCE and TCE concentration trends at select groundwater monitoring wells are shown in **Figure 5-1C**, **Figure 5-1D**, and **Figure 5-1E**. The highest COC detection in the AV plume between 2007 and 2012 was 54.6 µg/L (PCE) collected during data gap investigation activities at 95DP0224 in February 2008. The five highest PCE detections at AV in 2007 ranged from 18.2 to 34.6 µg/L. In 2012, the five highest PCE detections at AV ranged from 15 to 36 µg/L.

3. Through a combination of active treatment and natural attenuation, the plume remediation is progressing as expected. A review of the SPEIM data indicate that the plume extent and concentrations are declining as expected when compared to the modeling presented in the ROD. Therefore, the SPEIM data indicate that restoration timeframe predicted by groundwater modeling at the time of remedy selection (i.e., PCE and TCE concentrations decline to less than MCLs by approximately 2021) should be met or exceeded.

4. LTM data indicate the remedial goal for thallium (the MCL of 2 µg/L) has been reached and monitoring has been discontinued; however, Mn remains in groundwater at concentrations above the EPA HA of 300 µg/L to the west of Ashumet Pond. The Mn concentrations are expected to decline below the EPA HA over time as the aquifer becomes re-oxygenated and the effects on groundwater quality due to the treated wastewater plume that emanated from the MMR STP diminish.

5. Detectable concentrations of PCE and TCE continue to be reported in Backus River surface water samples providing evidence that the AV plume is discharging to the river (**Figure 5-1A**). In general, the surface water PCE and TCE concentration are highest along the northern reach of the river and adjacent bogs typically ranging from 1 to 3 µg/L (AFCEE 2008e, 2009b, 2010b, 2011b, 2012e; AFCEC 2013b); however, in 2006, PCE MCL exceedances (up to 9.3 µg/L) were detected in Backus River surface water (AFCEE 2007d). Relatively consistent PCE and TCE concentrations are seen along the southern reach of the river, although at generally lower concentrations (i.e., less than 1 µg/L). An agreement is in place with the AV stakeholder group (EPA, MassDEP, MassDPH and Cape Cod Cranberry Growers Association) that the Backus River cranberry crop will be considered suitable for market if PCE and TCE concentrations in surface water remain below MCLs. PCE or TCE in surface water have not been reported above the MCL since 2006 and therefore the 2007 through 2012 cranberry crops have been harvested (AFCEE 2008e, 2009b, 2010b, 2011b, 2012e; AFCEC 2013b).

Groundwater monitoring data collected in this area suggest that concentrations are declining over time due to the effects of natural attenuation and the PCE and TCE concentrations detected in surface water as a result of the plume discharging are also expected to decline in the future.

6. Neither PCE nor TCE have ever been detected in surface water samples collected from Ashumet Pond.

7. Agricultural irrigation wells are located near the Backus River and the 15 associated cranberry bogs (**Figure 5-1A**). Groundwater from these irrigation wells is used as a source of irrigation water by the cranberry farmer. Both PCE and TCE have been detected at concentrations above the MCL in two irrigation wells located along the northern reach of the river and bogs. PCE and TCE have been detected up to approximately 20 µg/L and 10 µg/L, respectively, in 2008/2009 (AFCEE 2009b and 2010b); however, more recent data from 2011 and 2012 indicate PCE and TCE concentrations have declined to below 10 µg/L and 5 µg/L, respectively, in these irrigation wells (AFCEE 2012e and AFCEC 2013b). A consultation with MassDPH in 2005 (MassDPH 2005) resulted in a finding that use of the Backus River irrigation water containing the AV COCs at the maximum concentrations detected historically (i.e., up to 20 µg/L) did not result in health concerns for the exposure assumptions considered. The irrigation wells will continue to be monitored under AFCEC's LUC Program.

8. Plume monitoring under AFCEC's SPEIM/LTM program should continue at AV to provide the necessary data to manage potential exposure risks, assess remedial progress, and evaluate optimization opportunities.

5.1.5.2 Site Inspections

Refer to Section 3.5.

5.1.5.3 Interviews

Refer to Section 3.6.

5.1.6 Technical Assessment

The technical assessment component of the Five Year Review consists of evaluating the protectiveness of the remedy. The technical assessment is based on EPA guidance provided in Section 4.0 of the Comprehensive Five Year Review Guidance (EPA 2001).

5.1.6.1 Question A: Is the remedy functioning as intended by the decision documents?

Yes, the completion of the ROD in 2009, construction and startup of the ETD system in 2009, continued operation of the remedial system, and completion of the well verification/well determination portion of the LUCs in early 2013 have resulted in the remedy functioning as intended by the decision documents. The ETI and ETD remedial systems are performing as expected. Plume and remedial system monitoring is being conducted under the SPEIM/LTM and LUC programs and risk management measures are in place to address discharge of the plume to the Backus River and associated cranberry bogs. Through the combination of the active treatment by the remedial systems and natural attenuation processes, groundwater cleanup levels are expected to be achieved within the timeframe approximated in the ROD (i.e., 2021). Operational costs are appropriate for the remedy and a robust optimization program continues with the objective of reducing remedial system operational timeframes, the time to reach remedial goals (e.g., MCLs), and reducing future costs. Monitoring and evaluation activities are continual and well-documented.

5.1.6.2 Question B: Are the exposure assumptions, toxicity data, cleanup levels, and remedial action objectives (RAOs) used at the time of the remedy selection still valid?

Changes in Standards and To-Be Considered: There have been no changes in standards or To Be Considered (TBC) guidance.

Changes in Exposure Pathways: There have been no changes to exposure pathways or land use of the site that would affect the protectiveness of the remedy. It is noted that a more thorough evaluation of the VI pathway was completed at AV since the completion of the ROD and the VI pathway was found to be incomplete (AFCEE 2012a).

Changes in Toxicity and Other Contaminant Characteristics. There have been changes in the toxicity factors that were in place at the time of the last Five Year Review (i.e., 2007) for the AV groundwater COCs PCE, TCE and thallium.

For PCE, the carcinogenic toxicity values (oral and inhalation) became less conservative, while the non-cancer toxicity values (oral and inhalation) became more conservative but by less than an order of magnitude (EPA 2013). These toxicity changes for PCE did not lead to a change in the MCL of 5 μg/L.

For TCE, the carcinogenic toxicity values (oral and inhalation) and oral non-cancer toxicity value became less conservative, while the inhalation non-cancer toxicity value is now 17.5 times more conservative. TCE was classified as a mutagen by EPA in November 2011 (EPA 2013). This means that when performing risk calculations for child receptors, the TCE toxicity values need to be multiplied by adjustment factors to address the vulnerability of young receptors. These toxicity changes for TCE did not lead to a change in the MCL of 5 μg/L.

For thallium, an oral non-cancer toxicity value was published by EPA in October 2012 (EPA 2012). The updated oral non-cancer toxicity value is seven times more conservative than what was previously published by EPA Region 3 (EPA 2008). These toxicity changes for thallium did not lead to a change in the MCL of 2 μg/L. It is noted

that thallium is no longer detected at AV above the analytical reporting limit and monitoring for thallium has been discontinued (AFCEE 2012d).

As discussed in Section 5.1.5.1, PCE and TCE continue to be detected in groundwater sampled from two agricultural irrigation wells located near the Backus River. Based on the most recent sampling conducted in October 2012, the maximum detected concentrations are 8.2 μg/L (PCE) and 3.4 μg/L (TCE) (AFCEC 2013b). Since TCE concentrations in the agricultural irrigation wells are below the MCL, no health concerns should result from the continued use of these irrigation wells related to TCE.

In 2005, MassDPH evaluated potential health concerns associated with the Backus River irrigation wells and concluded that PCE concentrations in groundwater at these wells up to 20 μg/L should not result in health concerns for the exposure assumptions considered (MassDPH 2005). It is acknowledged that the 2005 evaluation used older (lower) toxicity values than are currently available for PCE. Therefore, the potential exposure risks from irrigation water containing PCE at a concentration of 10 μg/L has been re-evaluated for cranberry bog workers using updated toxicity values and the results indicate that potential risks are well within EPA and MassDEP acceptable levels. Based on the current PCE toxicity values, irrigation water containing PCE at concentrations up to 59 μg/L should not result in inhalation risks above the conservative end of EPA's acceptable risk range ($1x10^{-6}$) based on the conservative exposure assumptions considered (i.e., exposure for 8 hours per day, 250 days per year, for 25 years).

Since the RAOs and risk management decisions associated with AV for potable use of groundwater are currently based on MCLs for PCE, TCE, and thallium, the changes in toxicity values for these chemicals do not affect the protectiveness of the remedy. In addition, the continued use of groundwater from the Backus River irrigation wells containing TCE at concentrations below the MCL and PCE at concentrations above the MCL (and up to 59 μg/L) for spray irrigation are less than the conservative end of EPA's acceptable risk range, and, therefore, the changes in toxicity values do not affect the protectiveness of the remedy. However, the updated toxicity values for the AV COCs (or values derived from future updates) should be used when performing the residual risk

assessment as part of the three-step process to achieve site closure (AFCEE 2011b). In addition, if the TCE concentration at the Backus River irrigation wells increases above the MCL in the future, the evaluation conducted by MassDPH in 2005 should be updated using the most current TCE toxicity information at the time the evaluation is completed to determine whether use of these wells could result in health concerns.

Changes in Risk Assessment Methods: There were no changes in risk assessment methodology.

Review of RAOs: The RAOs developed for the final ROD (AFCEE 2009a) are appropriate and remain valid.

5.1.6.3 Question C: Has any other information come to light that could call into question the protectiveness of the remedy?

No.

5.1.7 Issues, Recommendations, and Follow-Up Actions

No specific recommendation or follow-up actions have been identified. However, the topic of emerging contaminants should be monitored as it relates to groundwater at the MMR. Specifically for AV groundwater, sampling and analysis plans shall be submitted to the regulatory agencies to assess the possible presence of 1,4-dioxane and perfluorinated compounds.

5.1.8 Protectiveness Statement

The remedy for the AV groundwater plume is protective of human health and the environment. The remedial systems are performing as expected. The LUCs are in place and are functioning as intended. Through the combination of the active treatment by the remedial systems and natural attenuation processes, groundwater cleanup levels are expected to be achieved within the timeframe approximated in the ROD which was considered reasonable given the particular circumstances of the site.

5.1.9 References

ABB (ABB Environmental Services, Inc.). 1995 (April). *Draft Ashumet Valley Groundwater Operable Unit Remedial Investigation Report*. Prepared by ABB Environmental Services Inc. for HAZWRAP Support Contractor Office, Oak Ridge National Laboratory, Oak Ridge, TN.

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5.2 CHEMICAL SPILL-4 (CS-4) GROUNDWATER

The CS-4 plume is a dissolved-phase groundwater plume (**Figure 5-2A**) that contains the following four COCs: PCE, TCE, 1,1,2,2-tetrachloroethane (1,1,2,2-TeCA), and ethylene dibromide (EDB). The CS-4 plume boundary is defined as the extent of groundwater containing the COC PCE at concentrations exceeding its MCL of 5 µg/L. The remaining three COCs are detected sporadically and are co-located with the PCE contamination. The cleanup levels for these COCs are as follows: MCL for TCE is 5 µg/L; the MCP Method 1 GW-1 standard for 1,1,2,2-TeCA is 2 µg/L; and the Massachusetts MCL (MMCL) for EDB is 0.02 µg/L.

5.2.1 Site Chronology

1986: The IRP Phase I Records Search identified CS-4 as an MMR site that required further investigation (E.C. Jordan Co., 1986).

1989: The Phase I MW-603 groundwater study concluded that chlorinated solvents were associated with soil contamination found at the CS-4 source area and had migrated off-MMR toward potential groundwater receptors (E.C. Jordan Co. 1990a).

1992: A focused feasibility study was prepared (ANG 1992b), and the IROD remedy consisted of an ETI system with thirteen extraction wells intended to prevent further migration of the CS-4 plume (ANG 1992a).

1993: This ETI system began operation in September 1993.

1986 – mid 1990s: Numerous other investigations (E.C. Jordan Co. 1990b, 1990c) were conducted which culminated in an RI report prepared in 1998 (AFCEE 1999c). Results of the RI and the *Final Technical Memorandum AOC CS-4 Hydraulic Performance Evaluation* (AFCEE 1997) indicated that the interim remedial system was not capturing the entire CS-4 plume.

1999: Following the RI, another feasibility study was completed in 1999 to assess remedial alternatives to replace the existing ineffective system (AFCEE 1999b) and the proposed plan was released to the public in June 1999 (AFCEE 1999a).

2000: Preparation of the ROD (AFCEE 2000).

2003: The original CS-4 treatment system was turned off in May 2003 because of its ineffectiveness (AFCEE 2003), and was decommissioned in 2004 (AFCEE 2004a).

2004: Completion of the final wellfield design consisting of three CS-4 extraction wells that were installed as part of the Southwest Plumes remedial system, which was designed to collectively remediate the CS-4, CS-20, CS-21, and FS-29 groundwater plumes (AFCEE 2004b) (**Figure 5-2A**).

2005: Remedy in place was achieved in November 2005 with the startup of the new CS-4 treatment system (AFCEE 2008d).

2008: An ESD was submitted to document changes to the selected remedy for CS-4 related to the expected extent of plume capture and to further describe the institutional controls associated with the remedy (AFCEE 2008b).

2011: An ESD was prepared that clarified the inclusion of MNA as a component of the selected remedy, slightly modified the phrasing of the RAOs, and added text regarding the MMR three-step process to achieve site closure (AFCEE 2011b).

5.2.2 Background

5.2.2.1 History of Contamination

The source of the CS-4 groundwater plume is CS-4 West Truck Road Motor Pool. The source area included a former gasoline station, a former bus terminal, a suspected waste disposal pit, piles of sand and debris, a wetland, and two areas that receive storm-water runoff. CS-4 was operated for the maintenance of military vehicles by the U.S. Army

from 1940 to 1946 and by the USAF from 1955 to 1973. Wastes generated and potentially spilled or dumped during this period included oils, solvents, antifreeze, battery electrolytes, paint, and waste fuels (ANG 1992a, AFCEE 2008a).

In addition to motor pool activities, the base Defense Property Disposal Office (DPDO) maintained a storage yard in the northern portion of CS-4 between 1965 and 1983. Wastes were transported to the DPDO from shops and laboratories operating at MMR. Wastes and equipment handled at CS-4 included transformers, electrical equipment, waste oils, solvents, and waste fuels. Liquid wastes were stored in containers or tanks in an unbermed area, or deposited in six 5,000-gallon USTs installed to store motor gasoline when the motor pools were operational. The USTs were used until January 1984; in September 1984, the last USTs used for waste storage were emptied and removed. The area has been inactive since 1986 (ANG 1992a).

5.2.2.2 Physical Characteristics, Land and Resource Use

Based on the most recent groundwater monitoring data collected in 2012, the CS-4 plume is approximately 3,000 ft long, has a maximum width of approximately 800 ft, and is up to 60 ft thick in the aquifer (**Figure 5-2A**). The footprint of the CS-4 plume was approximately 51 acres in 2007, and was approximately 48 acres in 2012 (**Figure 5-2B**).

The land above the CS-4 plume is undeveloped woodlands used for recreational purposes (hiking, biking, hunting, etc.) within the CWMA, which is managed by the MDFW (**Figure 5-2A**). The CS-4 plume is located within a broad, flat, gently sloping glacial outwash plain. Within the footprint of the plume, the maximum and minimum ground surface elevations are 102 ft msl and 88 ft msl, respectively.

5.2.2.3 Initial Responses

A summary of the initial responses is as follows:

Non-CERCLA Actions: None.

CERCLA Actions:

CS-4 Source Area: AFCEE conducted several source removals at CS-4 West Truck Road Motor Pool. In 1994, more than 13,000 tons of contaminated soils at the CS-4 site were treated using an on-site thermal treatment unit. AFCEE removed 24 drainage structures and 3,000 tons of contaminated soil from the CS-4 source area in 1996. In 2001, an additional 5,200 tons of contaminated soils, along with an old UST, were removed from the site (AFCEE 2008a). These removal actions resulted in a no further action decision for CS-4 (AFCEE 2005).

CS-4 Groundwater Plume: A focused feasibility study was prepared in 1992 to evaluate the interim remedial alternatives for containing the CS-4 groundwater plume (ANG 1992b). An IROD was developed to implement a remedy to address groundwater contamination at CS-4 (ANG 1992a). In 1993, an interim groundwater treatment system was installed and became operational. Thirteen extraction wells were installed with the goal of capturing the CS-4 plume and were arranged in a fence configuration perpendicular to the direction of groundwater flow (**Figure 5-2A**). Extracted groundwater was treated using GAC and then discharged to the subsurface via two infiltration trenches. However, results of the *Final Technical Memorandum AOC CS-4 Hydraulic Performance Evaluation* (AFCEE 1997) and the Southwest Operable Unit (SWOU) RI (AFCEE 1999c) indicated that the interim remedial system was not capturing the entire CS-4 plume.

Following the 1998 SWOU RI (AFCEE 1999c), another feasibility study was completed in 1999 (AFCEE 1999b). A proposed plan was released to the public in June 1999 (AFCEE 1999a) to solicit comments on the preferred alternative (Alternative 6). The selected remedy for CS-4 as specified in the ROD was Alternative 6; groundwater extraction and treatment through the installation of three new extraction wells, treatment at the original CS-4 treatment plant using GAC, performance monitoring of the CS-4 plume and remedial system, and institutional controls (AFCEE 2000). In May 2003 and subsequent to the issuance of the ROD, AFCEE, with concurrence from the EPA and the MassDEP, turned off the original CS-4 treatment system because of its ineffectiveness

(AFCEE 2003). The original CS-4 treatment system was decommissioned in 2004 (AFCEE 2004a).

The final design for the new CS-4 remedial system consisted of three extraction wells (02EW0014, 02EW0015, and 02EW0016 shown on Figure 5-2A) and began operation on 28 November 2005 at a design extraction rate of 620 gpm (AFCEE 2008d). Extracted groundwater is treated by GAC in the centrally-located Hunter Avenue Treatment Facility (HATF) and the treated water is returned to the aquifer through reinjection wells, an infiltration trench, and an infiltration gallery. Further details regarding the CS-4 remedial system can be found in the 2012 O&M Plan (AFCEE 2012b).

An ESD was submitted in 2008 to document changes to the selected remedy for CS-4 (AFCEE 2008b). The primary difference between the cleanup strategy identified in the ROD and the final design is that the selected alternative presented in the ROD anticipated that the entire CS-4 plume would be hydraulically captured by the remedial system; however, the final design allowed the groundwater contamination in the downgradient leading edge of CS-4 to reach cleanup levels through natural attenuation instead of through active treatment. While analyzing various designs for system performance, effectiveness, property access issues, and other constraints, the final design for CS-4 was developed to meet the RAOs described in Section 5.2.3, while allowing for a relatively small portion of the plume to attenuate naturally.

An ESD for the IRP groundwater plumes was submitted in September 2011 that clarified the inclusion of MNA as a component of the selected remedy, slightly modified the phrasing of the RAOs, and updated the steps to achieve site closure (i.e., the three-step process) (AFCEE 2011b).

5.2.2.4 Basis for Taking Action

The baseline cancer risk calculations in the SWOU RI indicated that unless remedial action is undertaken, future residential exposure to the CS-4 COCs in groundwater may present an excess lifetime cancer risk greater than the acceptable MassDEP threshold of

$1x10^{-5}$ and the acceptable EPA range of $1x10^{-4}$ to $1x10^{-6}$. Ecological risks associated with the CS-4 groundwater plume were evaluated during the RI and no significant risk was identified (AFCEE 1999c).

5.2.3 Remedial Actions

The final remedy for the CS-4 plume was determined in the *Final Record of Decision for the CS-4, CS-20, CS-21, and FS-13 Plumes* (AFCEE 2000) which was signed on 18 February 2000.

The RAOs for the CS-4 groundwater plume as presented in the ROD (AFCEE 2000) and modified in the ESD (AFCEE 2011b) are as follows:

- Prevent residential exposure to CS-4 groundwater with PCE concentrations greater than the MCL of 5 μg/L.
- Prevent residential exposure to CS-4 groundwater with TCE concentrations greater than the MCL of 5 μg/L.
- Prevent residential exposure to CS-4 groundwater with 1,1,2,2-TeCA concentrations greater than the Massachusetts GW-1 standard of 2 μg/L.
- Prevent residential exposure to CS-4 groundwater with EDB concentrations greater than the MMCL of 0.02 μg/L.
- Restore useable groundwaters to their beneficial uses wherever practicable, within a timeframe that is reasonable given the particular circumstances of the site.

5.2.3.1 Remedy Selection and Implementation

The selected remedy for CS-4 groundwater in the ROD (AFCEE 2000) included the following components:

- Discontinue operation of the existing CS-4 plume extraction well fence.
- Install new extraction wells and treat extracted water at the original CS-4 remedial plant with treatment via GAC.
- If additional treatment capacity is necessary, the extracted water will be treated at the CS-20 treatment plant.

- Institutional controls to mitigate exposure to humans from CS-4 groundwater contaminants. In 1999, the Falmouth BOH adopted water well regulations to minimize the risk of exposure to groundwater contamination.
- Engineering controls to mitigate exposure to humans from CS-4 groundwater contaminants. Residents potentially impacted by the plume are connected to a public water supply.
- Plume monitoring and performance monitoring of the treatment system.
- Completion of CERCLA reviews every five years throughout the lifetime of the remedial action.

Since the remedy was selected in 2000, the following changes have occurred:

a) The Wellfield Design (AFCEE 2004b) presented the revised plan to treat the four Southwest Plumes (CS-4, CS-20, CS-21, and FS-29) via GAC at a centrally-located treatment plant (HATF) on the MMR.

b) The institutional controls described in the ROD were further developed as described in the Southwest Plumes ESD (AFCEE 2008b). The ESD provides a more thorough description of the LUC Program, including a private well verification program that is being instituted for all the MMR groundwater sites.

c) The 2011 ESD for the IRP groundwater plumes (AFCEE 2011b) clarified the inclusion of MNA as a component of the selected remedy for CS-4, slightly modified the phrasing of the RAOs, and added text regarding the MMR three-step process to achieve site closure.

The CS-4 remedial system was installed in 2005 and began operation on 28 November 2005 using three extraction wells at a total flow rate of 620 gpm.

Remedial system performance monitoring data and long-term plume monitoring data collected under the SPEIM/LTM program are used to assess: (i) whether the remedial objectives and system performance metrics are being met; (ii) whether remediation is progressing as expected; and (iii) to identify and assess optimization opportunities. The data collected under the SPEIM/LTM program are presented to the regulatory agencies through the Technical Update meeting process and documented in annual SLRs.

As part of the LUC process specified in the ROD and subsequent ESD (AFCEE 2000, 2008b), a private well verification survey was completed for the Southwest Plumes (including CS-4) between April 2009 and August 2011. This private well verification

survey consisted of outreach to 497 parcels. Responses were obtained from 100 percent of the property owners within the LUC area and there were no private wells identified on properties within the CS-4 LUC area (AFCEE 2012d). In the event that new private well information is obtained or plume monitoring data indicate a change to the CSM at CS-4, AFCEC will perform the necessary well determinations at the time the information becomes available.

5.2.3.2 <u>Remedy Operation & Maintenance</u>

The CS-4 remedial system is operated and maintained under an approved O&M Plan (AFCEE 2012b). The O&M Plan is updated on an annual basis and includes operational requirements, a summary of the operational history of the systems, and details of any system modifications, optimizations, or improvements. While occasional operational issues are identified, these issues have been, and continue to be, addressed in a timely and effective manner such that O&M associated with the remedy is considered effective at achieving the remedy goals. Operational issues are identified in O&M monthly reports and system performance and reliability is reported in the annual SLRs.

The annual SPEIM/LTM/O&M costs associated with ongoing remedial actions at CS-4 are generally consistent with those predicted at the time of remedy selection (with consideration for savings associated with optimization initiatives) and do not indicate potential remedy problems.

5.2.4 Progress Since the Last Five Year Review

Per the EPA guidance document (EPA 2001), this section summarizes the progress made on the specific recommendations and follow-up actions presented in the prior third CERCLA Five Year Review (AFCEE 2008a). For the CS-4 groundwater plume, the recommendations and follow-up actions were:

1) Section 4.1 of the third Five Year Review recommended that a screening level VI evaluation be completed for each IRP groundwater site. The objective of the VI evaluation was to determine if a VI exposure pathway exists at a particular site,

and if so, complete a screening level evaluation to determine if VI risk above target levels is likely or unlikely.

2) Section 4.3 of the third Five Year Review recommended that, in order to ensure long term protectiveness, all groundwater sites with off-base plume areas must undergo the well verification process as described in AFCEC's guideline titled *Verification, Decommissioning, and Documentation Guidelines for Private Wells in Areas of Potential Concern* (AFCEE 2008f). It was recommended that this requirement be codified in an ESD for those off-base groundwater sites with RODs that do not currently contain the well verification language as part of the required LUCs. For off-base groundwater sites without final RODs at the time of the third Five Year Review (AV and CS-10), the well verification language should be included in the LUC requirements presented in the final RODs.

3) The RAOs in the ROD required that the Air Force "prevent or reduce residential exposure". The third Five Year Review recommended that the RAOs be modified to eliminate the word "reduce" to better ensure long-term protectiveness.

Progress since the last Five Year Review against these recommendations and follow-up actions is as follows:

1) A VI evaluation was completed for the 16 IRP groundwater sites at the MMR as documented in the *Final 2011 MMR Vapor Intrusion Evaluation Technical Memorandum* (AFCEE 2012a) including CS-4. The VI evaluation indicated an incomplete pathway for VI at CS-4 and no further monitoring or data collection is needed specific to VI at CS-4. However, as part of the ongoing remedial actions at CS-4, AFCEC will continue to monitor the nature and extent of the CS-4 plume under the SPEIM program and will re-evaluate the VI exposure pathway if conditions change such that VI could be a concern.

2) The *Final Explanation of Significant Differences for CS-4, CS-20, CS-21, FS-13, FS-28, and FS-29 Groundwater Plumes* (AFCEE 2008b) was signed on 26 September 2008 and included the requirement to complete the private well

verification portion of the LUCs within three years of the signing of the ESD. This well verification effort was completed in 2011 and concluded that no private wells that were identified present an unacceptable exposure risk from the CS-4 groundwater (AFCEE 2012d). Further details of the well verification process and findings are included in Section 5.2.3.1.

3) The 2011 ESD for the IRP groundwater plumes (AFCEE 2011b) modified the phrasing of the RAOs to remove the word "reduce." The revised RAOs are presented in Section 5.2.3.

5.2.5 Five Year Review Process

5.2.5.1 Data Review

The MMR SPEIM program was developed to monitor plume changes and to ensure the effective operation of the AFCEC groundwater remediation systems at the MMR. These objectives are met through monitoring of selected media (i.e., groundwater, surface water) within and outside the plume boundaries, treatment plant monitoring, and groundwater flow and transport modeling. The data collected under the SPEIM program are continually assessed by a team of on-site professional staff and the results of these assessments are presented to the regulatory agencies initially during Technical Update meetings and then through technical memoranda or project note deliverables, if warranted, based on the results of the data evaluation or to address particular plume issues.

In addition, AFCEC prepares annual SLRs for the groundwater plumes that are being addressed through active treatment. The purpose of these SLRs is to document the results of sampling activities conducted at each plume under the SPEIM program. The SLRs also include: (i) a summary of all major events and optimizations completed at the plume; (ii) O&M-related system performance information such as contaminant mass removal/air emissions, system flow rate summaries, and downtime summaries; and (iii) all relevant technical assessment documentation completed during the annual reporting period as attachments or by reference. The SLRs are provided to the broad

stakeholder group for each plume including Federal (EPA) and State (MassDEP, MassDPH) regulatory agencies, town departments (such as the BOHs, Departments of Public Work, Water Departments, and/or Conservation Commissions), affected property owners, and other interested parties. The SLRs are publically available in the IRP Administrative Record and copies are maintained at the local town libraries.

In addition to the annual SLRs prepared for the Southwest Plumes (including CS-4) during this Five Year Review period (AFCEC 2013b, AFCEE 2012c, 2011d, 2010b, 2009b, 2008g), the following technical deliverables were prepared that assessed system performance or presented the results of optimization evaluations:

- *Final CS-4, CS-20, CS-21 and FS-29 Baseline SPEIM Report* (AFCEE 2008e)
- *Southwest Plumes 2008 Annual SPEIM Data Presentation Project Note* (AFCEE 2008c)
- *Southwest Plumes 2009 Triennial SPEIM Data Presentation Project Note* (AFCEE 2009a)
- *CS-4 Extraction Well 02EW0016 Interim Shut Down Project Note* (AFCEE 2010c)
- *Southwest Plumes 2010 Annual SPEIM Data Presentation Project Note* (AFCEE 2010a)
- *Final Chemical Spill-4 2010 Remedial System Optimization Technical Memorandum* (AFCEE 2011c)
- *Southwest Plumes 2011 Annual SPEIM Data Presentation Project Note* (AFCEE 2011a)
- *Southwest Plumes 2012 Triennial SPEIM Data Presentation Project Note* (AFCEC 2012)

While additional details are provided in the documents listed above, the primary findings and conclusions from these system performance evaluations at CS-4 are as follows:

1. The CS-4 remedial system removed approximately 20 lbs of COCs through the treatment of approximately 660 million gallons of groundwater during this Five Year Review period. The CS-4 remedial system has treated approximately 1.3 billion gallons of contaminated groundwater and removed

approximately 33 lbs of COCs between system startup (November 2005) and December 2012. The original CS-4 treatment system removed approximately 30 lbs of COCs through the treatment of approximately 765 million gallons of groundwater between September 1993 and May 2003.

2. A comparison of the CS-4 plume boundary at the start and end of this Five Year Review period (i.e., 2007 versus 2012) is included on **Figure 5-2B**. COC concentration trends at select groundwater monitoring wells are shown in **Figure 5-2C**. The highest COC detection in the CS-4 plume between 2007 and 2012 was PCE at 43.7 µg/L collected from monitoring well 02OW0016D in March 2007. The five highest COC detections at CS-4 in 2007 were for PCE and ranged from 8.8 to 43.7 µg/L. In 2012, the five highest COC detections at CS-4 were for PCE and ranged from 12 to 21 µg/L (**Figure 5-2C**).

3. Through a combination of active treatment and natural attenuation, the plume remediation is progressing as expected. A review of the SPEIM data indicate that the plume extent and concentrations are declining as expected, and the restoration timeframe predicted by groundwater modeling at the time of remedy selection (i.e., COC concentrations decline to less than MCLs by approximately 2017) should be met. In contrast, the overall model-predicted aquifer restoration timeframe estimated from the most recent groundwater transport modeling (AFCEE 2011c) is longer than that predicted at the time of the ROD (2029 vs. 2017). A review of the most recent CS-4 transport simulation reveals an issue similar to that observed during the recent optimization assessment at CS-20 (AFCEC 2013a) where contamination lingered in low hydraulic conductivity units simulated in the model. The most recent CS-4 modeling results indicate that the majority of the transmissive portion of the aquifer should reach MCLs by 2017, which is consistent with monitoring data. The fate of the contamination that remains after that date in the model simulation is highly uncertain and likely a modeling artifact that is commonly observed in MMR modeling results. In a manner similar to that

performed at CS-20 (AFCEC 2013a), the most recent CS-4 transport simulations should be rerun without loading PCE mass in the low hydraulic conductivity units (where supported by data) to provide a more accurate estimated aquifer restoration timeframe.

4. A remedial system optimization assessment completed in 2009 and 2010 provided evidence that the operation of 02EW0016 was successful in remediating the portion of the plume it was intended to address (AFCEE 2010c, 2011c). Therefore, extraction well 02EW0016 was shut down on 09 December 2009 with regulatory agency concurrence.

5. The only surface water body in the vicinity of the CS-4 plume is the kettle pond Coonamessett Pond, which is located approximately 3,000 ft south (and hydraulically downgradient) of the leading edge of the plume (**Figure 5-2A**). No VOCs have ever been detected in surface water samples collected from Coonamessett Pond.

6. Plume monitoring under AFCEC's SPEIM/LTM program should continue at CS-4 to provide the necessary data to manage potential exposure risks, assess remedial progress, and evaluate optimization opportunities.

5.2.5.2 Site Inspections

Refer to Section 3.5.

5.2.5.3 Interviews

Refer to Section 3.6.

5.2.6 Technical Assessment

The technical assessment component of the Five Year Review consists of evaluating the protectiveness of the remedy. The technical assessment is based on EPA guidance provided in Section 4.0 of the Comprehensive Five Year Review Guidance (EPA 2001).

5.2.6.1 Question A: Is the remedy functioning as intended by the decision documents?

Yes, the completion of the ROD in 2000, construction and startup of the remedial system in 2005, continued operation of the remedial system, and completion of the well verification/well determination portion of the LUCs in 2011 have resulted in the remedy at CS-4 functioning as intended by the decision documents. The remedial system is performing as expected. Although modeling results indicate an aquifer restoration timeframe of 2029, there is significant uncertainty in that prediction related to the fate of contamination in low hydraulic conductivity units (see Section 5.2.5.1). Monitoring results indicate MCLs should be reached in the transmissive portion of the aquifer by the ROD predicted aquifer restoration timeframe of approximately 2017. A modeling-based remedial system optimization assessment will be completed to provide a more accurate estimate of the aquifer restoration timeframe for the CS-4 plume.

Plume and remedial system monitoring is being conducted under the SPEIM/LTM and LUC programs and risk management measures are in place to ensure protection of human health and the environment. Operational costs are appropriate for the remedy and a robust optimization program continues with the objective of reducing remedial system operational timeframes, the time to reach remedial goals (e.g., MCLs), and reducing future costs. Monitoring and evaluation activities are continual and well-documented.

5.2.6.2 Question B: Are the exposure assumptions, toxicity data, cleanup levels, and remedial action objectives (RAOs) used at the time of the remedy selection still valid?

Changes in Standards and To-Be Considered: There have been no changes in standards or TBC guidance.

Changes in Exposure Pathways: There have been no changes to exposure pathways or land use of the site that would affect the protectiveness of the remedy. Since the VI exposure pathway was not considered in the RI, a more thorough evaluation has been completed and the VI pathway was found to be incomplete (AFCEE 2012a).

Changes in Toxicity and Other Contaminant Characteristics. There have been no changes in the toxicity factors or other contaminant characteristics for the CS-4 groundwater COC EDB during this Five Year Review period and the MMCL remains at 0.02 μg/L. However, toxicity values that were in place at the time of the last Five Year Review (i.e., 2007) have changed for the other CS-4 groundwater COCs.

For PCE, the carcinogenic toxicity values (oral and inhalation) became less conservative, while the non-cancer toxicity values (oral and inhalation) became more conservative but by less than an order of magnitude (EPA 2013). These toxicity changes for PCE did not lead to a change in the MCL of 5 μg/L.

For TCE, the carcinogenic toxicity values (oral and inhalation) and oral non-cancer toxicity value became less conservative, while the inhalation non-cancer toxicity value is now 17.5 times more conservative. TCE was classified as a mutagen by EPA in November 2011 (EPA 2013). This means that when performing risk calculations, the TCE toxicity values need to be multiplied by adjustment factors to address the vulnerability of earlier aged receptors. These toxicity changes for TCE did not lead to a change in the MCL of 5 μg/L.

For 1,1,2,2-TeCA, there has been no change in carcinogenic toxicity values since the last Five Year Review. However, EPA added an oral non-cancer toxicity value for 1,1,2,2-TeCA in September 2010 (EPA 2013). These toxicity changes for 1,1,2,2-TeCA did not lead to a change in the Massachusetts GW-1 standard of 2 μg/L.

In conclusion, since the RAOs and risk management decisions associated with CS-4 groundwater are based on MCLs/MMCLs/GW-1 standards, these changes in toxicity values do not affect the protectiveness of the remedy. However, these updated toxicity values (or values derived from future updates) should be used when performing the residual risk assessment as part of the three-step process to achieve site closure (AFCEE 2011b).

Changes in Risk Assessment Methods: There were no changes in risk assessment methodology.

Review of RAOs: The RAOs developed for the final ROD (AFCEE 2000) and revised in the 2011 ESD (AFCEE 2011b) are appropriate and remain valid.

5.2.6.3 Question C: Has any other information come to light that could call into question the protectiveness of the remedy?

No.

5.2.7 Issues, Recommendations, and Follow-Up Actions

Since current transport modeling projections predict a restoration timeframe (2029) beyond that predicted at the time of remedy selection (2017) and as discussed in Section 5.2.5.1, a modeling-based remedial system optimization assessment will be completed for the CS-4 plume. In a manner similar to that performed at CS-20 (AFCEC 2013a), the most recent CS-4 transport simulations will be rerun without loading PCE mass in the low hydraulic conductivity units (where supported by data) to provide a more accurate estimated aquifer restoration timeframe.

In addition, the topic of emerging contaminants should be monitored as it relates to groundwater at the MMR. Specifically for CS-4 groundwater, a sampling and analysis plan shall be submitted to the regulatory agencies to assess the possible presence of 1,4-dioxane.

5.2.8 Protectiveness Statement

The remedy for the CS-4 groundwater plume is protective of human health and the environment. The remedial system is performing as expected. The LUCs are in place and are functioning as intended. Through the combination of the active treatment by the remedial system and natural attenuation processes, groundwater cleanup levels are expected to be achieved within the timeframe approximated in the ROD which was considered reasonable given the particular circumstances of the site.

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5.3 CHEMICAL SPILL-10 (CS-10) GROUNDWATER

The CS-10 plume is a dissolved-phase groundwater plume (**Figure 5-3A**) that is defined by the extent of groundwater containing the CS-10 plume COCs, TCE and PCE, at concentrations exceeding the federal MCL of 5 µg/L for each compound. There are four separate areas in the CS-10 plume: (1) the In-Plume (IP) area, (2) the Sandwich Road lobe, (3) the southern trench area, and (4) and the leading edge area which is comprised of three lobes: the Northern lobe (NL) (formerly known as the TCE plume); North-Central lobe (NCL); and Southern lobe (SL). Each of these areas is shown on **Figure 5-3A**.

5.3.1 Site Chronology

1985: The primary CS-10 source area, UTES/BOMARC, was investigated and several chlorinated organics were detected in the groundwater (E.C. Jordan Co. 1986).

1986–1988: An SI identified numerous contamination sources in the BOMARC area and detected contaminants in the soil and groundwater (E.C. Jordan Co. 1989 and 1990).

1989–1990: An interim RI was completed (ABB-ES 1992).

1992–1997: An RI report was completed for the potential source areas within the UTES/BOMARC area (CDM 1997). A separate RI report was completed for the groundwater plume (CDM 1996).

1994-1995: The NGB, DoD, EPA, MassDEP, and local communities approved a Plume Response Plan that presented an accelerated effort toward "simultaneous containment" of seven groundwater plumes including CS-10. An IROD for the seven groundwater plumes emanating from the MMR was signed on 25 September 1995 (ANG 1995). The IROD stated that groundwater extraction and treatment systems should be designed, installed, and operated until a final remedy for the site is chosen. For CS-10, the interim remedy included active treatment for the plume upgradient of Ashumet Pond.

1997-2000: Completion of an RI which focused on the leading edge of the CS-10 plume located hydraulically downgradient of Sandwich Road (AFCEE 2001a).

1999-2000: The Sandwich Road ETR system and the CS-10 IP ETI system were installed under the IROD. The Sandwich Road ETR system began operation on 18 May 1999 and the CS-10 IP ETI system began operation on 24 June 1999. On 27 April 2000, the CS-10 IP system was supplemented with the start-up of the Southwest/Southern system (AFCEE 2001b).

2000: Completion of a time-critical removal action for the NL due to high TCE concentrations in groundwater potentially discharging to Johns Pond surface water. The action consisted of the installation of one extraction well which began operation in January 2000 to prevent discharge of TCE into Johns Pond (AFCEE 2000).

2004: Extraction well 03EW2111 was added to the CS-10 IP system in 2004 as part of an optimization effort (AFCEE 2005b).

2005–2007: A data gap investigation was completed in the southern trench area to delineate contamination located outside of the remedial system capture zone (AFCEE 2008g).

2008: Completion of a feasibility study for CS-10 groundwater (AFCEE 2008c).

2009: Completion of a proposed plan (AFCEE 2009g) and the final ROD for CS-10 groundwater (AFCEE 2009b). The final remedy included continued operation of the CS-10 interim remedial systems plus the installation of a new extraction well (03EW2112) at the leading edge of the Southern Trench lobe, the installation of a new reinjection well (03RI2112) southeast of 03EW2111, and modification of the Sandwich Road and CS-10 IP extraction and reinjection/infiltration well flow rates. The new extraction well (03EW2112) and reinjection well (03RI2112) were installed in 2008 and remedy in place was achieved by February 2009 (AFCEE 2010c).

2011: An ESD was prepared that clarified the inclusion of MNA as a component of the selected remedy, slightly modified the phrasing of the RAOs, and added text regarding the MMR three-step process to achieve site closure (AFCEE 2011a).

2008-2012: Data gap investigation activities were completed to further assess the extent of contamination in the IP areas and Sandwich Road lobe. Data were used to update the CSM which will be the basis for a remedial system optimization evaluation (AFCEC 2013c, 2013e; AFCEE 2013).

5.3.2 Background

5.3.2.1 History of Contamination

The main source of the CS-10 groundwater plume is referred to as CS-10/FS-24. CS-10/FS-24 occupies approximately 38 acres at the eastern boundary of the MMR to the west of Snake and Weeks ponds. Originally, the CS-10/FS-24 consisted of a number of buildings constructed as part of the BOMARC site by the USAF.

Maintenance operations associated with the BOMARC systems involved the use of cleaning solvents (methylene chloride, 1,1,1-TCA, TCE, PCE, and Freon). BOMARC fuels included JP-4, Aerozine-50, red fuming nitric acid, and hydrazine. Fuels used for power and heat generation included No. 2 fuel oil and diesel fuel. Several buildings had floor drains connected to leaching wells, building sumps, oil interceptors, and other drainage structures; some of these drainage structures were connected to the site storm drain system. The facility was abandoned by the USAF in 1973 (AFCEE 2008b). Shelters utilized by the missile launcher systems along with a subsurface utility corridor connecting the shelters (utilidor system) were removed from the site in 2005. For more information regarding the CS-10 source area removal activities, refer to Section 4.1.

The UTES has been in operation at this site since 1978 and is currently used by the Massachusetts ARNG as the UTES facility for maintenance and storage of vehicles. UTES personnel are responsible for maintaining vehicles used for ARNG training activities. Motor oil, hydraulic fluid, battery electrolyte, PCE, PD-680 Safety Clean,

paints, and paint removers have been used on-site (AFCEE 2008b). Although the BOMARC and UTES facilities are considered the primary sources of contamination to the CS-10 plume, numerous other sources of contamination are presumed to have contributed to the CS-10 plume as it traveled beneath the MMR.

5.3.2.2 Physical Characteristics, Land and Resource Use

Based on the most recent groundwater monitoring data collected in 2012, the main body of the CS-10 plume (which includes the IP area, Sandwich Road Lobe, and Southern Trench area) is nearly 3 miles long and over 1 mile wide (Figure 5-3A). The most upgradient portion of the CS-10 NL is located approximately 550 ft downgradient of the MMR base boundary, and is approximately 3,800 ft long and up to 660 ft wide. The NCL is approximately 3,600 ft long and up to 700 ft wide. The SL is approximately 1,600 ft long and up to 400 ft wide. The footprint of the four portions of the CS-10 plume was approximately 1,062 acres in 2007, and was approximately 1,383 acres in 2012 (Figure 5-3B). The data density increased significantly since 2007 and the plume footprint was expanded based on this new understanding of the plume nature and extent (AFCEC 2013e).

On-base land use in the vicinity of the CS-10 plume consists primarily of areas used for military operations. The area south of the base is characterized by residential areas, and undeveloped woodlands and wetlands used for recreation and conservation. Surface water bodies (known as kettle ponds) in the vicinity of the CS-10 plume (Ashumet Pond and Johns Pond [Figure 5-3A]) are recharged by groundwater and precipitation; and provide for recreational use such as fishing, swimming, and boating. The land above the CS-10 plume can be characterized as a broad, flat, gently southward sloping glacial outwash plain. Within the footprint of the plume, the maximum and minimum ground surface elevations are 144 ft msl and 38 ft msl, respectively.

The Mashpee Village Public Water Supply Well (PWSW) is located on the east side of Johns Pond (Figure 5-3A). This PWSW well operates at an average flow rate of approximately 108 gpm, but is permitted for a maximum flow rate of 500 gpm.

Contamination attributed to CS-10 was detected on the eastern side of Johns Pond in 2003 (AFCEE 2005a). The former Eastern Lobe of the CS-10 plume was located approximately 150 ft below the Mashpee Village PWSW screen and 450 ft north of the MassDEP Zone II delineation for this water supply well. In addition, the former Eastern Lobe was located beneath the Mashpee Village PWSW zone of contribution for the average long term pumping rate (108 gpm) and was located near the bottom of the zone of contribution at the maximum permitted flow rate (500 gpm). Therefore, the Mashpee Village PWSW was not, and is not, expected to be affected by contamination from the CS-10 plume (AFCEE 2005a).

5.3.2.3 Initial Responses

A summary of the initial responses is as follows:

Non- CERCLA Actions

Several non-CERCLA source removal activities occurred at the CS-10 source area in 1996. At the CS-10 source area, 16 drainage structures were removed as part of the DSRP. In addition, a leaking 25,000 gallon UST was removed. For more information regarding the CS-10 source area removal activities, refer to Section 4.1.

CERCLA Actions

The DoD and the EPA, with concurrence from the MassDEP, implemented an interim action for the CS-10 groundwater plume and six other MMR plumes under an IROD (ANG 1995). The selected remedy involved extraction of contaminated groundwater, treatment of that water and subsequent discharge to the groundwater and institutional controls.

The TRET, established in 1996 as part of a new IROD management process, reviewed wellfield designs and determined that the 60-percent design for containment of several of the IROD plumes would cause negative ecological impacts (TRET 1996). The proposed interim remedy for the CS-10 groundwater plume was therefore revised and included

active treatment for the plume upgradient of Ashumet Pond. The selected alternative relied on ETR and ETI technology to capture contaminated groundwater using an extraction fence along Sandwich Road and additional extraction wells within the body of the CS-10 plume.

The Sandwich Road ETR system began operation on 18 May 1999 and consisted of eight extraction wells and six reinjection wells. The water is processed through GAC units at the SRTF. The CS-10 IP groundwater remedial system was started up on 24 June 1999. On 27 April 2000, the CS-10 IP system was supplemented with the start-up of the Southwest/Southern system. The two systems were comprised of eight extraction wells and two infiltration trenches, with groundwater processed through GAC units at the CS-10 IP treatment plants (**Figure 5-3A**). A ninth extraction well (03EW2111) was added in 2004 as part of an optimization effort to address contamination in the southern trench area (AFCEE 2005b).

AFCEE also committed to further investigation of the area downgradient of Sandwich Road and the northwest shoreline of Ashumet Pond. As part of the investigations, the leading edge lobes of the CS-10 plume were delineated under Ashumet Pond and between Ashumet and Johns ponds. Due to the high concentrations of TCE detected in groundwater within the NL and the knowledge that it was discharging into Johns Pond surface water, remediation proceeded under a time-critical removal action (AFCEE 2000).

The time-critical removal action for the NL consisted of one extraction well which began operation in January 2000 to prevent discharge of TCE into Johns Pond by containing the plume at Hoophole Road. Extracted water is piped to the SRTF for treatment through GAC and is returned to the aquifer through reinjection wells.

Increasing concentrations in monitoring wells located in the Southern Trench area, outside of the interim remedial system capture zone, prompted the need for a data gap investigation that was conducted between January 2005 and June 2007 (AFCEE 2008g). The CS-10 2007 groundwater model (AFCEE 2008g) and the revised CS-10 2007 TCE

plume shell were used in a remedial system optimization evaluation to predict the extent of hydraulic capture, assess system performance including contaminant mass removal and plume migration over time, and to assess the potential hydraulic impacts (AFCEE 2009d). The optimized pumping condition determined during this evaluation is presented as Alternative 10 in the *Final Supplement to the Chemical Spill-10 Groundwater Feasibility Study Addendum* (AFCEE 2008c) and became the operation configuration for the selected remedy in the *Final Record of Decision for Chemical Spill-10 Groundwater* (AFCEE 2009b). The selected remedy included the installation of a new extraction well (03EW2112) at the leading edge of the Southern Trench lobe and the installation of a new reinjection well (03RI2112) southeast of 03EW2111. The new extraction well (03EW2112) and reinjection well (03RI2112) were installed in 2008 and the system optimization was implemented in February 2009. Further details regarding the CS-10 remedial system can be found in the 2012 O&M Plan (AFCEE 2012c).

5.3.2.4 <u>Basis for Taking Action</u>

Future residential exposure to CS-10 groundwater COCs present an excess lifetime cancer risk greater than the acceptable MassDEP threshold of 1×10^{-5} and the acceptable EPA range of 1×10^{-4} to 1×10^{-6} (CDM 1996 and AFCEE 2001a). An ecological risk assessment concluded that discharge of the CS-10 plume to surface waters does not pose a threat to ecological receptors (AFCEE 2009b).

5.3.3 Remedial Actions

The final remedy for the CS-10 plume was determined in the *Final Record of Decision for Chemical Spill-10 Groundwater* (AFCEE 2009b) which was signed in August 2009.

The RAOs for the CS-10 groundwater plume as presented in the ROD (AFCEE 2009b) and modified in the ESD (AFCEE 2011a) are as follows:

- Prevent residential exposure to CS-10 groundwater with TCE concentrations greater than the MCL of 5 µg/L.

- Prevent residential exposure to CS-10 groundwater with PCE concentrations greater than the MCL of 5 µg/L.
- Restore usable groundwaters to their beneficial uses wherever practicable, within a timeframe that is reasonable given the particular circumstances of the site.

5.3.3.1 Remedy Selection and Implementation

The selected remedy in the ROD (AFCEE 2009b) included the following components:

- Continued operation of the existing optimized IP ETI system, NL ETR system, and the Sandwich Road ETR system with system expansion into the Southern Trench area with an additional extraction well and an additional reinjection well to improve capture of the plume in that area. The flow from the new extraction well will be treated at the SRTF and returned to the aquifer through the CS-10 and SD-5 reinjection wells. The flow to the new reinjection well will come from the CS-10 IP treatment facility via the Southern Infiltration Trench. The contaminated groundwater is removed from the aquifer through extraction wells and piped to the treatment plants. Contaminants are removed from the groundwater through GAC filtration. The treated groundwater is returned to the aquifer via infiltration trenches or reinjection wells.
- Implementation of LUCs with the performance objectives of:
  - Preventing access to, or use of, contaminated groundwater from the CS-10 plume (both off-site and on-site) until the groundwater no longer poses an unacceptable risk, and
  - Maintaining the integrity of the current or future remedial or monitoring system such as the treatment systems and monitoring wells.
- Chemical and hydraulic monitoring of the plume under the SPEIM program, as long as active remediation continues, and chemical monitoring of the plume until the RAOs are met.
- Completion of CERCLA reviews every five years throughout the lifetime of the remedial action.

Since the groundwater remedy was selected in 2009, the following changes have occurred:

- The 2011 ESD for the IRP groundwater plumes (AFCEE 2011a) clarified the inclusion of MNA as a component of the selected remedy for CS-10, slightly modified the phrasing of the RAOs, and added text regarding the MMR three-step process to achieve site closure.

Remedial system performance monitoring data and long-term plume monitoring data collected under the SPEIM/LTM program are used to assess: (i) whether the remedial objectives and system performance metrics are being met; (ii) whether remediation is progressing as expected; and (iii) to identify and assess optimization opportunities. The data collected under the SPEIM/LTM program are presented to the regulatory agencies through the Technical Update meeting process and documented in annual SLRs.

A private well verification and well determination process was completed at CS-10 between January 2010 and August 2012 as part of the LUC process specified in the ROD (AFCEE 2009b). The private well verification survey completed at the CS-10 LUC area consisted of outreach to 336 parcels and identified a total of 120 parcels that have one or more private wells (AFCEC 2013a). A non-potable water supply well (B-well) is also located within the on-base portion of the CS-10 LUC area; this well will be sampled annually as part of the LUC Program starting in 2013. Technical evaluations were completed for each private well and for the on-base well to determine the sampling frequency and/or re-evaluation frequencies (if necessary), and those results are provided in the *Final Chemical Spill-10 Private Well Verification and Well Determination Project Note* (AFCEC 2013a). No private wells that were identified present an unacceptable exposure risk from the CS-10 plume.

The status of non-operational private wells in the CS-10 LUC area will continue to be tracked. AFCEC will distribute a mailing, on an annual basis, to property owners within the LUC area that have non-operational wells for which no technical evaluation could be completed due to lack of known well depths and inability to sample. The intent of the annual mailing is to remind these property owners that they should contact AFCEC for a technical evaluation, which may include sampling, in the event their well is put back into service. In addition to these annual mailings, AFCEC will perform outreach as part of future Five Year Reviews to each of the property owners requiring confirmation of the non-operational status of their wells (AFCEC 2013b).

5.3.3.2 Remedy Operation & Maintenance

The CS-10 remedial systems are operated and maintained under an approved O&M Plan (AFCEE 2012c). The O&M Plan is updated on an annual basis and includes operational requirements, a summary of the operational history of the systems, and details of any system modifications, optimizations, or improvements. While occasional operational issues are identified, these issues have been, and continue to be, addressed in a timely and effective manner such that O&M associated with the remedy is considered effective at achieving the remedy goals. Operational issues are identified in O&M monthly reports and system performance and reliability is reported in the annual SLRs.

The annual SPEIM/LTM/O&M costs associated with ongoing remedial actions at CS-10 are generally consistent with those predicted at the time of remedy selections (with consideration for savings associated with optimization initiatives) and do not indicate potential remedy problems.

5.3.4 Progress Since the Last Five Year Review

Per the EPA guidance document (EPA 2001), this section summarizes the progress made on the specific recommendations and follow-up actions presented in the prior third CERCLA Five Year Review (AFCEE 2008b). For the CS-10 groundwater plume, the recommendations and follow-up actions were:

1) Section 4.1 of the third Five Year Review recommended that a screening level VI evaluation be completed for each IRP groundwater site. The objective of the VI evaluation was to determine if a VI exposure pathway exists at a particular site, and if so, complete a screening level evaluation to determine if VI risk above target levels is likely or unlikely.

2) Section 4.3 of the third Five Year Review recommended that, in order to ensure long term protectiveness, all groundwater sites with off-base plume areas must undergo the well verification process as described in AFCEC's guideline titled *Verification, Decommissioning, and Documentation Guidelines for Private Wells*

in Areas of Potential Concern (AFCEE 2008e). It was recommended that this requirement be codified in an ESD for those off-base groundwater sites with RODs that do not currently contain the well verification language as part of the required LUCs. For off-base groundwater sites without final RODs at the time of the third Five Year Review (AV and CS-10), the well verification language should be included in the LUC requirements presented in the Final RODs.

3) Section 4.4.3 of the third Five Year Review indicated that the interim CS-10 remedial system was not functioning as intended since a portion of the CS-10 plume in the southern trench area had moved beyond the base boundary.

Progress since the last Five Year Review against these recommendations and follow-up actions is as follows:

1) A VI evaluation was completed for the 16 IRP groundwater sites at the MMR as documented in the *Final 2011 MMR Vapor Intrusion Evaluation Technical Memorandum* (AFCEE 2012b) including CS-10. The VI evaluation indicated the VI exposure pathway is either incomplete or insignificant at CS-10 and no further monitoring or data collection is needed specific to VI at CS-10 (AFCEE 2012b). However, as part of the ongoing remedial actions at CS-10, AFCEC will continue to monitor the nature and extent of the CS-10 plume under the SPEIM program and will re-evaluate the VI exposure pathway if conditions change such that VI could be a concern.

2) The final remedy for the CS-10 plume was determined in the *Final Record of Decision for Chemical Spill-10 Groundwater* (AFCEE 2009b) which was signed in August 2009 and included the requirement to complete the private well verification portion of the LUCs within three years of the signing of the ROD. This well verification effort was completed in 2012 and concluded that no private wells that were identified present an unacceptable exposure risk from the CS-10 groundwater (AFCEC 2013a). Further details of the well verification process and findings are included in Section 5.3.3.1.

3) The final remedy presented in the *Final Record of Decision for Chemical Spill-10 Groundwater* (AFCEE 2009b) consisted of continued operation of the CS-10 remedial system plus expansion of the system through the addition of an extraction well and reinjection well to address the portion of the CS-10 plume in the southern trench area that had moved beyond the base boundary. The new extraction well (03EW2112) and reinjection well (03RI2112) were installed in 2008 and became operational in February 2009 (AFCEE 2010c).

5.3.5 Five Year Review Process

5.3.5.1 Data Review

The MMR SPEIM program was developed to monitor plume changes and to ensure the effective operation of the AFCEC groundwater remediation systems at the MMR. These objectives are met through monitoring of selected media (i.e., groundwater, surface water) within and outside the plume boundaries, treatment plant monitoring, and groundwater flow and transport modeling. The data collected under the SPEIM program are continually assessed by a team of on-site professional staff and the results of these assessments are presented to the regulatory agencies initially during Technical Update meetings and then through technical memoranda or project note deliverables, if warranted, based on the results of the data evaluation or to address particular plume issues.

In addition, AFCEC prepares annual SLRs for the groundwater plumes that are being addressed through active treatment. The purpose of these SLRs is to document the results of sampling activities conducted at each plume under the SPEIM program. The SLRs also include: (i) a summary of all major events and optimizations completed at the plume; (ii) O&M-related system performance information such as contaminant mass removal/air emissions, system flow rate summaries, and downtime summaries; and (iii) all relevant technical assessment documentation completed during the annual reporting period as attachments or by reference. The SLRs are provided to the broad stakeholder group for each plume including Federal (EPA) and State (MassDEP,

MassDPH) regulatory agencies, town departments (such as the BOHs, Departments of Public Work, Water Departments, and/or Conservation Commissions), affected property owners, and other interested parties. The SLRs are publically available in the IRP Administrative Record and copies are maintained at the local town libraries.

In addition to the annual SLRs prepared for CS-10 during this Five Year Review period (AFCEC 2013c, AFCEE 2012e, 2011c, 2010e, 2009c, 2008f), the following technical deliverables were prepared that assessed system performance or presented the results of optimization evaluations:

- *CS-10 2012 Remedial System Optimization Workplan Project Note, Phase II Approach* (AFCEC 2013c)
- *CS-10 2012 Remedial System Optimization Workplan Project Note, Phase I Approach* (AFCEE 2013)
- *Final Chemical Spill-10 2012 Data Gap Investigation Technical Memorandum* (AFCEC 2013e)
- *CS-10 2010/2011 Biennial SPEIM/LTM Data Presentation Project Note* (AFCEE 2012g)
- *CS-10 2011 Southern Trench Area Optimization Project Note* (AFCEE 2012f)
- *CS-10 2011 Annual SPEIM/LTM Data Presentation Project Note* (AFCEE 2012d)
- *CS-10 In-Plume 03EW2104 Modifications Project Note submitted* (AFCEE 2012a)
- *GSI Matrix Diffusion Study – Results from Pilot Test Location 03BH1060/03GB1060 Project Note* (AFCEE 2011d)
- *GSI Matrix Diffusion Study – Results from Second Pilot Test Location 03DP2000/03BH2000 Project Note* (AFCEE 2011b)
- *Final Chemical Spill-10 In Situ Chemical Oxidation Pilot Test Technical Memorandum* (AFCEE 2010a)
- *CS-10 Extraction Well 03EW2106 Interim Shut Down Project Note* (AFCEE 2010f)
- *CS-10 2009 Semiannual SPEIM/LTM Data Presentation Project Note* (AFCEE 2010d)
- *CS-10 2009 Annual SPEIM/LTM Data Presentation Project Note* (AFCEE 2010b)

- *Final CS-10 2008 Southern Trench System Optimization Project Note* (AFCEE 2009d)
- *Supplemental CS-10 Leading Edge Data Gap Field Investigation – Summary and Results Project Note* (AFCEE 2009e)
- *CS-10 2009 System Optimization Startup Plan Project Note* (AFCEE 2009f)
- *CS-10 2008 Biennial SPEIM/LTM Data Presentation Project Note* (AFCEE 2009a)
- *Final Chemical Spill-10 2007 Southern Trench Technical Memorandum* (AFCEE 2008g)
- *CS-10 2008 Semiannual SPEIM/LTM Data Presentation Project Note* (AFCEE 2008a)
- *CS-10 2007 Annual SPEIM/LTM Data Presentation Project Note* (AFCEE 2008d)
- *CS-10 2007 Semiannual SPEIM/LTM Data Presentation Project Note* (AFCEE 2007)
- Quarterly data transmittals for the Ashumet and Johns Ponds Long Term Monitoring Program (2007 to 2009)
- Quarterly data transmittals of the monitoring results for the Mashpee Water Supply Well (2007 to 2009)

While additional details are provided in the documents listed above, the primary findings and conclusions from these system performance evaluations and the data gap investigation at CS-10 are as follows:

1. The CS-10 remedial systems removed approximately 1,668 lbs of TCE and PCE through the treatment of approximately 8 billion gallons of groundwater during this Five Year Review period. In total, the CS-10 remedial systems have treated approximately 23.1 billion gallons of contaminated groundwater and removed approximately 6,361 lbs of TCE and PCE since system startup through December 2012.

2. Data gap investigation activities conducted between 2008 and 2012 led to an update in the CS-10 CSM (AFCEC 2013e). Changes to the CSM included a more thorough understanding of the nature and extent of contamination in the IP area, particularly in the area of CS-10 IP extraction wells 03EW2012,

03EW2103, 03EW2104, and 03EW2107 and to the west and east of the former CS-10 plume boundary. These new data were used to update the CS-10 groundwater model and plume shell which will be used as the basis of an optimization evaluation (AFCEC 2013c, AFCEE 2013). A comparison of the CS-10 plume boundary at the start and end of this Five Year Review period (i.e., 2007 versus 2012) is included on **Figure 5-3B**. The 2012 plume boundary is based on the extent of contamination determined during the data gap investigation. As shown on **Figure 5-3B**, the CS-10 2012 plume boundary has been extended to encompass recently delineated contamination located outside the previous plume boundary. The volume of TCE contamination in the CS-10 IP area based on the 2012 characterization is approximately thirty-six percent greater that the volume considered at the time of remedy selection which was based on data collected through 2007. In addition to the increase in the extent of TCE contamination in the CS-10 IP area, the data gap investigation identified higher TCE concentrations within the plume boundary that were not characterized at the time of remedy selection in 2009. The estimated TCE contaminant mass within the CS-10 IP area is approximately twice what was identified at the time of remedy selection. A comparison of the 2007 and 2012 TCE plume shells illustrates the difference in the TCE concentrations and distribution of contaminant mass before and after the data gap investigation in the main body (north of Ashumet Pond) of the CS-10 plume (**Figure 5-3C**). The highest concentration in the 2007 TCE plume shell was 450 µg/L at 03MW1024D and the highest concentration in the 2012 TCE plume shell was 3,880 µg/L at rotosonic boring 03MW1069A that was installed during the data gap investigation in May 2010. The five highest TCE detections at CS-10 in 2007 ranged from 229 to 925 µg/L. In 2012, the five highest TCE detections at CS-10 ranged from 300 to 586 µg/L (note that the wells installed at boring 03MW1069A were not sampled during 2012). This broad range of TCE detections between 2007, 2012, and from the data gap investigation activities illustrates the heterogeneous nature of the main body of the CS-10 plume. TCE

concentrations trends at select groundwater monitoring wells in the leading edge lobes are shown in **Figures 5-3D** and **5-3E**.

3. Fate and transport modeling completed in support of remedy selection (AFCEE 2009b) indicated that remedial system shutdown would occur by approximately 2055 and aquifer restoration would be achieved by approximately 2094 in a scenario where Alterative 10 operating conditions ran for the duration of the simulation. Using the CS-10 2012 TCE plume shell (which was updated based on the data gaps investigation results) and the updated 2012 CS-10 groundwater flow model, and assuming the CS-10 remedial systems will operate continuously under the current pumping configuration (2012 Scenario 01), groundwater transport modeling results indicate that system shutdown would occur by approximately 2065 and by 2112 MCLs have been reached with the exception of one isolated area of TCE contamination that remains deep in the aquifer in the IP area (AFCEC 2013e). This difference between the model-predicted operational timeframe and restoration timeframe is due to the change in the CSM including the updated extent of TCE contamination and refinements in the hydraulic conductivity field which controls how groundwater flow is simulated by the model. An optimization evaluation is underway for the CS-10 IP and Sandwich Road systems with the objective of reducing the system operational timeframe, the aquifer restoration timeframe, and improving plume capture by the system (AFCEC 2013c and AFCEE 2013). This CS-10 2012 remedial system optimization effort will be documented in a technical memorandum.

4. Two off-line Sandwich Road extraction wells (03EW2176 and 03EW2177) were turned back on in 2011 after TCE MCL exceedances were observed in 03EW2177 (during sampling of the off-line well). A zone of TCE contamination has been delineated in this area to the east of the Sandwich Road lobe. This newly delineated zone of contamination is believed to have migrated past the eastern end of the Sandwich Road extraction fence when extraction wells 03EW2176 and 03EW2177 were offline (AFCEC 2013e).

The CS-10 LUC boundary was extended to include the area downgradient of the Sandwich Road (AFCEC 2013a). Groundwater transport modeling results indicate that this lobe of contamination is likely being contained at Sandwich Road under current system operating conditions with these wells operating. Optimization of the Sandwich Road system will be evaluated as part of the CS-10 IP optimization modeling effort (AFCEC 2013e and AFCEE 2013).

5. CS-10 IP extraction well 03EW2106 was taken out of operation on 24 February 2010. Performance monitoring data indicated that operation of 03EW2106 had been successful in remediating the portion of the plume within its zone of hydraulic capture (AFCEE 2010f). The TCE concentrations at 03EW2106 and in the area of 03EW2106 continue to support the shutdown of this well (AFCEC 2013c).

6. Southern Trench extraction well 03EW2112 began operation in February 2009 at the pumping configuration presented in the ROD (AFCEE 2009b). Plume and performance monitoring data indicated the leading edge of the CS-10 plume in this Southern Trench area had not yet reached the extraction well and the well was temporarily turned off in April 2009. A field program to help determine when the leading edge of the plume had migrated to 03EW2112 and to collect the data needed to evaluate optimized scenarios for the operation of 03EW2112 was initiated in 2009 and continued through 2010 (AFCEE 2012f). A focused update of the 2007 TCE plume shell for the Southern Trench area was used with the 2007 groundwater flow model to evaluate optimization scenarios for 03EW2112 and the well began operating at the optimized scenario, which included a flow rate of 100 gpm with a packered configuration, on 19 January 2011. This operational scenario (2012 Scenario 01) improves plume capture at southern trench extraction well 03EW2112 and the CS-10 Sandwich Road ETR system.

7. Increasing TCE influent concentrations observed at NL extraction well 00EW0001 and increasing concentrations in upgradient monitoring wells identified the potential for optimization of this well. After flow testing at progressively increasing flow rates to determine if the flow rate could be optimized to improve performance; the flow rate was increased to 225 gpm. Based on monitoring results and modeling predictions the extraction well is containing the plume and operating as designed (AFCEE 2012g).

8. TCE and PCE concentrations detected in the NCL and SL LTM network are generally consistent with previous results and with the CSM for these two lobes. Therefore, attenuation of the plume in these areas is progressing as expected.

9. Monitoring data collected on the east side of Johns Pond (**Figure 5-3A**) as part of the LTM program are consistent with the CSM and confirm that the Mashpee Village PWSW and sentry wells are not impacted by the CS-10 plume. TCE concentrations at one well located on the east side of Johns Pond (00MW0584A), where low-level MCL exceedances (5.1 to 5.8 µg/L) were observed between 2003 and 2004, increased above the MCL to 6.2 µg/L in March 2011 and have fluctuated above and below the MCL since then. This monitoring well is screened deep in the aquifer (-238 to 243 ft msl), just above bedrock; contamination at this location will not have an impact on the Mashpee Village PWSW (AFCEE 2005a). AFCEE sampled the Mashpee Village PWSW and sentry wells between 2004 and 2009 and TCE and PCE were not detected. A sentry well monitoring program for the Mashpee Village PWSW has been solely performed by the Town of Mashpee since January 2009.

10. Plume monitoring under AFCEC's SPEIM/LTM program should continue at CS-10 to provide the necessary data to manage potential exposure risks, assess remedial progress, and evaluate optimization opportunities.

5.3.5.2 Site Inspections

Refer to Section 3.5.

5.3.5.3 Interviews

Refer to Section 3.6.

5.3.6 Technical Assessment

The technical assessment component of the Five Year Review consists of evaluating the protectiveness of the remedy. The technical assessment is based on EPA guidance provided in Section 4.0 of the Comprehensive Five Year Review Guidance (EPA 2001).

5.3.6.1 Question A: Is the remedy functioning as intended by the decision documents?

Yes, completion of the ROD in 2009 (AFCEE 2009b), construction and startup of the remedial system components added to the interim system as part of the final remedy in 2009, continued operation of the remedial systems, and completion of the well verification/well determination portion of the LUCs in early 2013 have resulted in the remedy functioning as intended by the decision documents. However, based on results of a data gap investigation completed in 2012 that updated the CS-10 CSM, the timeframe for aquifer restoration is now predicted to be longer than the timeframe presented in the ROD (i.e., 2112 instead of 2094) (AFCEC 2013e). The primary reason for this difference is due to a change in the CSM where previously uncharacterized TCE contamination has been identified in the IP area at higher concentrations and deeper in the aquifer where hydraulic conductivities are lower than previously depicted in the model simulations available at the time of remedy selection. An optimization evaluation is ongoing with the goal of reducing the predicted time period for remedial system operation and aquifer restoration. The updated restoration timeframe approximation will be compared to the information presented in the ROD and will be used to determine whether the RAO related to aquifer restoration (see Section 5.3.3) is being achieved.

It should be noted that during this Five Year Review period a zone of TCE contamination was delineated to the east of the Sandwich Road lobe. This newly delineated zone of contamination is believed to have migrated past the eastern end of the Sandwich Road extraction fence when extraction wells 03EW2176 and 03EW2177 were offline (AFCEC 2013e). The two off-line Sandwich Road extraction wells (03EW2176 and 03EW2177) were turned back on in 2011 after TCE MCL exceedances were observed in 03EW2177 (during sampling of the off-line well). Groundwater transport modeling results indicate that this lobe of contamination is likely being contained at Sandwich Road under current system operating conditions, cleanup of this area is not expected to prolong the overall aquifer restoration timeframe. The CS 10 LUC boundary was extended to include the area downgradient of the Sandwich Road where this contamination migrated (AFCEC 2013a).

Plume and remedial system monitoring is being conducted under the SPEIM/LTM and LUC Programs and risk management measures are in place. Operational costs are appropriate for the remedy and a robust optimization program continues with the objective of reducing remedial system operational timeframes, the time to reach remedial goals (e.g., MCLs), and reducing future costs. Monitoring and evaluation activities are continual and well-documented.

5.3.6.2 Question B: Are the exposure assumptions, toxicity data, cleanup levels, and remedial action objectives (RAOs) used at the time of the remedy selection still valid?

Changes in Standards and To-Be Considered: There have been no changes in standards or TBC guidance.

Changes in Exposure Pathways: There have been no changes to exposure pathways or land use of the site that would affect the protectiveness of the remedy. Since the VI exposure pathway was not considered during the RI, a screening evaluation of the VI pathway was completed at CS-10 and the VI pathway was found to be incomplete or insignificant (AFCEE 2012b).

<u>Changes in Toxicity and Other Contaminant Characteristics</u>: There have been changes in the toxicity factors that were in place at the time of the last Five Year Review (i.e., 2007) for the CS-10 groundwater COCs PCE and TCE since the last Five Year Review.

For TCE, the carcinogenic toxicity values (oral and inhalation) and oral non-cancer toxicity value became less conservative, while the inhalation non-cancer toxicity value is now 17.5 times more conservative. TCE was classified as a mutagen by EPA in November 2011 (EPA 2013). This means that when performing risk calculations, the TCE toxicity values need to be multiplied by adjustment factors to address the vulnerability of earlier aged receptors. These toxicity changes for TCE did not lead to a change in the MCL of 5 μg/L.

For PCE, the carcinogenic toxicity values (oral and inhalation) became less conservative, while the non-cancer toxicity values (oral and inhalation) became more conservative but by less than an order of magnitude (EPA 2013). These toxicity changes for PCE did not lead to a change in the MCL of 5 μg/L.

Since the RAOs and risk management decisions associated with CS-10 groundwater are based on the MCL, these changes in toxicity values do not affect the protectiveness of the remedy. However, these updated toxicity values (or values derived from future updates) should be used when performing the residual risk assessment as part of the three-step process to achieve site closure (AFCEE 2011a).

<u>Changes in Risk Assessment Methods</u>: There were no changes in risk assessment methodology.

<u>Review of RAOs</u>: The RAOs developed for the ROD (AFCEE 2009b) and revised in the 2011 ESD (AFCEE 2011a) are appropriate and remain valid.

5.3.6.3 <u>Question C: Has any other information come to light that could call into question the protectiveness of the remedy?</u>

No.

5.3.7 Issues, Recommendations, and Follow-Up Actions

Contaminant transport modeling completed since the ROD indicate that the restoration timeframe predicted at the time of remedy selection (i.e., by 2094) may not be met. The longer model-predicted restoration timeframe is due to a change in the CSM related to the nature and extent of TCE contamination in the IP area of the plume.

An optimization assessment of the CS-10 remedial system is underway which will assess the performance of the remedial system, determine whether improvements can be made, and update the restoration timeframe prediction for comparison to the information presented in the ROD (AFCEC 2013c and AFCEE 2013). An ESD summarizing the updated CSM and the updated prediction for aquifer restoration timeframe should be completed for CS-10 following the completion of the optimization activities.

In addition, the topic of emerging contaminants should be monitored as it relates to groundwater at the MMR. Specifically for CS-10 groundwater, a sampling and analysis plan shall be submitted to the regulatory agencies to assess the possible presence of 1,4-dioxane.

5.3.8 Protectiveness Statement

The remedy for the CS-10 groundwater plume is protective of human health and the environment. The remedial system is performing as expected and the LUCs are in place and are functioning as intended. Through the combination of the active treatment by the remedial systems and natural attenuation processes, groundwater cleanup levels are expected to be achieved. However, due to a change in the CSM, the aquifer restoration timeframe may be longer than expected at the time of remedy selection and this will be further assessed. When an updated estimate of the aquifer restoration timeframe is available, it will be determined whether the RAO of restoring the aquifer in a reasonable timeframe is being met. Since the LUCs are in place and are functioning as intended to prevent exposure and there are no current plans to use the portion of the aquifer where CS-10 contamination is located for water supply, the remedy remains protective.

5.3.9 References

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5.4 CHEMICAL SPILL-19 (CS-19) GROUNDWATER

The CS-19 plume is a dissolved-phase groundwater plume defined as the extent of groundwater containing the COC, hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX), at concentrations exceeding its EPA risk-based level of 0.6 µg/L (based on a 1×10^{-6} excess lifetime cancer risk calculation). The CS-19 plume is located near the Central Impact Area (CIA) plume within the west central region of the MMR Impact Area (**Figure 5-4A**). The CIA plume is located hydraulically upgradient, crossgradient, and beneath the CS-19 plume.

5.4.1 Site Chronology

1991: The CS-19 source area was identified as a potential disposal site (ABB-ES, 1992a).

1991-2003: A series of literature reviews and several field investigations were completed which culminated in the CS-19 RI report (ABB-ES 1992a and 1992b, ANG 1992, AFCEE 1999 and 2003, IAGWSP 2003, Ogden 1999, USACHPPM 1994, AFCEE 2003).

2005: The IROD presented an interim remedy of LTM for the CS-19 plume (AFCEE 2005).

2009: The feasibility study was completed in April 2009 (AFCEE 2009f) and the proposed plan was released to the public in April 2009 (AFCEE 2009e). The selected remedy for CS-19 as specified in the ROD was MNA with LUCs (AFCEE 2009a).

2011: An ESD was prepared that slightly modified the phrasing of the RAOs and added text regarding the MMR three-step process to achieve site closure (AFCEE 2011a)

5.4.2 Background

5.4.2.1 History of Contamination

The CS-19 source area was used historically for ordnance disposal, which resulted in explosives contamination in site soil and groundwater. The site was initially defined as approximately one acre in size, as outlined by a perimeter road with an approximate 125-ft radius. A later interpretation of geophysical and chemical data collected during the source area soil removal action, along with visual assessment of site debris, indicated that the CS-19 perimeter road was an artificial boundary and did not reflect the extent of disposal activities at the site. The boundary of the CS-19 disposal area was extended outward beyond the perimeter road in all directions to include an additional 1.1 acres known as the CS-19 expansion area (AFCEE 2009b).

The CS-19 site expanded into the Bunker Area, which was identified because of a large magnetic anomaly detected during an aerial survey, and due to the information identified in a witness interview summary (IAGWSP 2003). According to the witness, the area around the bunker was known as Range 11 and was used by contractors for ordnance testing in the 1950s through the 1960s. The area was also used by the Army and National Guard for ordnance detonation. The testing operations were moved to the J-1 Range sometime in the 1960s because it was too difficult to make arrangements to use Range 11 due to the Army and National Guard artillery training (AFCEE 2008c).

5.4.2.2 Physical Characteristics, Land and Resource Use

Based on the most recent groundwater monitoring data collected in 2012, the CS-19 plume is approximately 6,800 ft long, has a maximum width of approximately 600 ft, and is up to 30 ft thick in the aquifer. The footprint of the CS-19 plume was approximately 18 acres in 2007, and was approximately 64 acres in 2012 (**Figure 5-4A**). The increase in plume acreage from 2007 to 2012 was the result of a more conservative depiction of the CS-19 plume in the ROD which assumed a continuous zone of RDX at concentrations above the EPA risk-based level of 0.6 µg/L between the source area and leading edge of the plume, and is not the result of an observed expansion of the plume.

The CS-19 site is presently inactive for military purposes, although the land use of the MMR Impact Area is still considered military and is designated as an operational range. The land over the CS-19 plume is primarily forested, and the CS-19 site is within a restricted area surrounded by fencing and guarded gates. The eastern portion of the CS-19 plume is located within a broad, flat, gently sloping glacial outwash plain, and the land over the western portion of the plume is a hummocky north-south trending ridge of moraine glacial deposits. Within the footprint of the plume, the maximum and minimum ground surface elevations are 258 ft msl and 180 ft msl, respectively.

5.4.2.3 Initial Responses

A summary of the initial responses is as follows:

Non-CERCLA Actions:

None.

CERCLA Actions:

CS-19 Source Area: Removal activities conducted at the CS-19 source area (including the CS-19 Bunker Area) between 2004 and 2006, and between 2007 and 2009 included the excavation of the top 2 to 3 ft of soil and the associated MEC. Based on confirmatory sampling, the EPA and the MassDEP agreed that the remaining RDX levels in soil are protective and that any leaching to groundwater would be well below risk-based levels (AFCEE 2009a).

CS-19 Groundwater Plume: The 2003 CS-19 RI (AFCEE 2003) concluded that active cleanup of the CS-19 plume was not necessary since the plume will attenuate naturally if the source is removed. AFCEE agreed to remove the source of the CS-19 plume, and an interim remedy of LTM was selected for the CS-19 plume in 2005 (AFCEE 2005). It was agreed that a final remedy would be evaluated in conjunction with the remedy selection process for the nearby CIA plume (EPA 2004). In 2008, AFCEE, EPA, and

MassDEP agreed that the CS-19 and CIA plume remedy selection process could be conducted separately (AFCEE 2009a).

The CS-19 feasibility study and proposed plan were completed in 2009 (AFCEE 2009c, 2009f). The selected remedy for CS-19 as specified in the ROD was MNA with LUCs (AFCEE 2009a).

An ESD was submitted for the IRP groundwater plumes in September 2011 that slightly modified the phrasing of the RAOs, and updated the steps to achieve site closure (i.e., the three-step process) (AFCEE 2011a).

5.4.2.4 Basis for Taking Action

The baseline cancer risk calculations in the CS-19 RI indicated that future residential exposure to the RDX in groundwater from a water supply well installed in the CS-19 plume may present an excess lifetime cancer risk greater than the acceptable MassDEP threshold of $1x10^{-5}$ and the acceptable EPA range of $1x10^{-4}$ to $1x10^{-6}$ (AFCEE 2003). An ecological baseline risk assessment was not conducted for groundwater because the CS-19 plume is not currently discharging to any surface water bodies, nor is it expected to in the future.

5.4.3 Remedial Actions

The final remedy for the CS-19 plume was determined in the *Final Chemical Spill-19 Record of Decision* (AFCEE 2009a) which was signed on 30 September 2009.

The RAOs for the CS-19 groundwater plume as presented in the ROD (AFCEE 2009a) and modified in the ESD (AFCEE 2011a) are as follows:

- Prevent residential exposure to CS-19 groundwater with RDX concentrations greater than the EPA risk-based level of 0.6 μg/L.
- Restore useable groundwaters to their beneficial uses wherever practicable, within a timeframe that is reasonable given the particular circumstances of the site.

5.4.3.1 Remedy Selection and Implementation

The selected remedy for CS-19 groundwater in the ROD (AFCEE 2009a) was MNA with LUCs and plume monitoring. In addition, CERCLA reviews are to be completed every five years throughout the lifetime of the remedial action.

LTM data collected under the SPEIM/LTM program are used to assess: (i) whether the remedial objectives are being met; and (ii) to identify and assess optimization opportunities. The data collected under the SPEIM/LTM program are presented to the regulatory agencies through the Technical Update meeting process.

As part of the LUC process specified in the ROD (AFCEE 2009a), a well verification survey was completed for CS-19 in January 2013. No active or inactive water-supply or irrigation wells were identified within the CS-19 LUC area. Additionally no private residential wells are known to exist within the CS-19 LUC area since the plume is located entirely within the boundary of the MMR (AFCEC 2013). In the event that new private well information is obtained or plume monitoring data indicate a change to the CSM at CS-19, AFCEC will perform the necessary well determinations at the time the information becomes available.

5.4.3.2 Remedy Operation & Maintenance

The periodic LTM costs associated with ongoing remedial action at CS-19 are generally consistent with those predicted at the time of remedy selection (with consideration for savings associated with optimization initiatives such as less frequent sampling as was assumed at the time of the remedy selection) and do not indicate potential remedy problems.

5.4.4 Progress Since the Last Five Year Review

Per the EPA guidance document (EPA 2001), this section summarizes the progress made on the specific recommendations and follow-up actions presented in the prior third

CERCLA Five Year Review (AFCEE 2008a). For the CS-19 groundwater plume, the recommendations and follow-up actions were:

1) Section 4.1 of the third Five Year Review recommended that a screening level VI evaluation be completed for each IRP groundwater site. The objective of the VI evaluation was to determine if a VI exposure pathway exists at a particular site, and if so, complete a screening level evaluation to determine if VI risk above target levels is likely or unlikely.

2) Section 4.4.4 of the third Five Year Review recommended development of final RAOs in the final ROD.

Progress since the last Five Year Review against these recommendations and follow-up actions is as follows:

1) A VI evaluation was completed for the 16 IRP groundwater sites at the MMR as documented in the *Final 2011 MMR Vapor Intrusion Evaluation Technical Memorandum* (AFCEE 2012a) including CS-19. The VI evaluation indicated an incomplete pathway for VI at CS-19 and no further monitoring or data collection is needed specific to VI at CS-19. However, as part of the ongoing remedial actions at CS-19, AFCEC will continue to monitor the nature and extent of the CS-19 plume under the SPEIM/LTM program and will re-evaluate the VI exposure pathway if conditions change such that VI could be a concern.

2) The final RAOs for the CS-19 plume were determined in the *Final Chemical Spill-19 Record of Decision* (AFCEE 2009a) which was signed on 30 September 2009.

5.4.5 Five Year Review Process

5.4.5.1 <u>Data Review</u>

The data collected under the SPEIM/LTM program are continually assessed by a team of on-site professional staff and the results of these assessments are presented to the

regulatory agencies initially during Technical Update meetings and then through technical memoranda or project note deliverables, if warranted, based on the results of the data evaluation or to address particular plume issues. The following technical deliverables were prepared that assessed remedial progress:

- *CS-19 2008 Annual Data Presentation Project Note* (AFCEE 2008b)
- *CS-19 2008 Semiannual Data Presentation Project Note* (AFCEE 2009d)
- *CS-19 2009 Annual Data Presentation Project Note* (AFCEE 2009c)
- *CS-19 2009 RDX Biodegradation Monitoring Discussion and Semiannual Data Presentation Project Note* (AFCEE 2010a)
- *CS-19 2010 Annual Data Presentation Project Note* (AFCEE 2010b)
- *CS-19 2011 Annual LTM Data Presentation Project Note* (AFCEE 2012b)
- *CS-19 2012 Annual LTM Data Presentation Project Note* (AFCEC 2012)

While additional details are provided in the documents listed above, the primary findings and conclusions from these performance evaluations at CS-19 are as follows:

1. A comparison of the CS-19 plume boundary at the start and end of this Five Year Review period (i.e., 2007 versus 2012) is included on **Figure 5-4A**. The increase in plume size from 2007 to 2012 was the result of a more conservative depiction of the CS-19 plume in the ROD which assumed a contiguous zone of RDX at concentrations above the cleanup level between the source area and leading edge of the plume. COC concentration trends at select groundwater monitoring wells are shown in **Figure 5-4B**. The highest RDX detection in the CS-19 plume between 2007 and 2012 was 15 µg/L collected from monitoring well 58MW0002 in January 2007. The five highest RDX detections at CS-19 in 2007 ranged from 2.7 to 15 µg/L. In 2012, the five highest RDX detections at CS-19 ranged from 0.85 to 4.38 µg/L (**Figure 5-4B**).

2. The RDX concentrations in the CS-19 plume are attenuating as expected and the restoration timeframe predicted by groundwater modeling at the time of remedy selection (i.e., RDX concentrations decline to less than the EPA risk-based level by approximately 2037) should be met or exceeded.

3. An assessment of RDX biodegradation at CS-19 indicated that the RDX breakdown product, hexahydro-1-nitroso-3,5-dinitro-1,3,5-triazine (MNX), was detected at estimated concentrations below the reporting limit in most monitoring wells where RDX was detected. The results of a literature review indicated that the occurrence of MNX typically results from the breakdown of RDX in an anaerobic environment. However, the aquifer at CS-19 is aerobic. The low detections of MNX at CS-19 suggest that a small degree of biodegradation may have occurred, or is occurring, somewhere along the RDX migration pathway, but the low MNX concentrations indicate biodegradation is an insignificant process. The physical processes of attenuation (dispersion, dilution, sorption) are playing a much more significant role in the attenuation of RDX at CS-19 than biodegradation (AFCEE 2010a).

4. Plume monitoring under AFCEC's SPEIM/LTM program should continue at CS-19 to provide the necessary data to manage potential exposure risks, assess remedial progress, and evaluate optimization opportunities.

5.4.5.2 Site Inspections

Refer to Section 3.5.

5.4.5.3 Interviews

Refer to Section 3.6.

5.4.6 Technical Assessment

The technical assessment component of the Five Year Review consists of evaluating the protectiveness of the remedy. The technical assessment is based on EPA guidance provided in Section 4.0 of the Comprehensive Five Year Review Guidance (EPA 2001).

5.4.6.1 Question A: Is the remedy functioning as intended by the decision documents?

Yes, the LTM activities and the implementation of the LUCs at CS-19 have resulted in the remedy functioning as intended by the decision documents. Through natural attenuation processes, groundwater cleanup levels are expected to be achieved within the timeframe approximated in the ROD (i.e., by 2037). Operational costs are appropriate for the remedy. Monitoring and evaluation activities are continual and well-documented.

5.4.6.2 Question B: Are the exposure assumptions, toxicity data, cleanup levels, and remedial action objectives (RAOs) used at the time of the remedy selection still valid?

Changes in Standards and To-Be Considered: There have been no changes in standards or TBC guidance.

Changes in Exposure Pathways: There have been no changes to exposure pathways or land use of the site that would affect the protectiveness of the remedy. It is noted that since the VI exposure pathway was not considered in the RI, a screening evaluation has been completed and the VI pathway was found to be insignificant at CS-19 (AFCEE 2012a).

Changes in Toxicity and Other Contaminant Characteristics: There have been no changes in the toxicity factors that were in place at the time of the last Five Year Review (i.e., 2007) or other contaminant characteristics for the CS-19 groundwater COC, RDX.

Changes in Risk Assessment Methods: There were no changes in risk assessment methodology.

Review of RAOs: The RAOs developed for the final ROD (AFCEE 2009a) are appropriate.

5.4.6.3 Question C: Has any other information come to light that could call into question the protectiveness of the remedy?

No.

5.4.7 Issues, Recommendations, and Follow-Up Actions

No specific recommendation or follow-up actions have been identified. However, the topic of emerging contaminants should be monitored as it relates to groundwater at CS-19 and the MMR.

5.4.8 Protectiveness Statement

The remedy for the CS-19 groundwater plume is protective of human health and the environment. Remediation is progressing as expected. The LUCs are in place and are functioning as intended. Through natural attenuation processes groundwater cleanup levels are expected to be achieved within the timeframe approximated in the ROD which was considered reasonable given the particular circumstances of the site.

5.4.9 References

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5.5 CHEMICAL SPILL-20 (CS-20) GROUNDWATER

The CS-20 plume is a dissolved-phase groundwater plume (**Figure 5-5A**) that is defined by the extent of groundwater containing the CS-20 COC, PCE, at concentrations exceeding the federal MCL of 5 μg/L.

5.5.1 Site Chronology

1997: The CS-20 plume was discovered in March 1997 during the drilling program to define the trailing edge of the FS-28 plume (AFCEE 1999c).

1998: The RI report was completed (AFCEE 1999c).

1999: The feasibility study was completed in June 1999 (AFCEE 1999b) and the proposed plan was released to the public in June 1999 (AFCEE 1999a).

2000: ROD finalized (AFCEE 2000).

2004: Completion of the final wellfield design consisting of two CS-20 extraction wells that were installed as part of the Southwest Plumes remedial system, which was designed to collectively remediate the CS-4, CS-20, CS-21, and FS-29 groundwater plumes (AFCEE 2004) (**Figure 5-5A**).

2006: Remedy in place achieved in January with the startup of the CS-20 treatment system (AFCEE 2008d).

2008: An ESD was submitted to document changes to the selected remedy for CS-20 related to the expected extent of plume capture and to further describe the institutional controls associated with the remedy (AFCEE 2008b).

2011: An ESD was prepared that clarified the inclusion of MNA as a component of the selected remedy, slightly modified the phrasing of the RAOs, and added text regarding the MMR three-step process to achieve site closure (AFCEE 2011b).

5.5.2 Background

5.5.2.1 History of Contamination

The CS-20 plume is detached from its source area which remains unidentified. It is speculated that contamination was released at the ground surface from a spill or release on the MMR, migrated through the vadose zone, and entered the groundwater at the water table. The dissolved phase contamination was then carried downgradient in groundwater in a south-southwesterly direction.

5.5.2.2 Physical Characteristics, Land and Resource Use

Based on the most recent groundwater monitoring data collected in 2012, the CS-20 plume is approximately 8,000 ft long, has a maximum width of approximately 700 ft, and is up to 50 ft thick in the aquifer (**Figure 5-5A**). The footprint of the CS-20 plume was approximately 163 acres in 2007, and was approximately 68 acres in 2012 (**Figure 5-5B**).

The land above the northern portion of the CS-20 plume (i.e., north of Route 151) is undeveloped woodlands used for recreational purposes (hiking, biking, hunting, etc.) within the CWMA, which is managed by the MDFW (**Figure 5-5A**). The land above the southern portion of the CS-20 plume is residential. The CS-20 plume is located within a broad, flat, gently sloping glacial outwash plain. Within the footprint of the plume, the maximum and minimum ground surface elevations are 108 ft msl and 58 ft msl, respectively.

5.5.2.3 Initial Responses

A summary of the initial responses is as follows:

Non-CERCLA Actions: None.

CERCLA Actions:

CS-20 Groundwater Plume: Following the 1998 RI (AFCEE 1999c), a feasibility study was completed in 1999 (AFCEE 1999b). A proposed plan was released to the public in June 1999 (AFCEE 1999a) to solicit comments on the preferred alternative (Alternative 5). The selected remedy for CS-20 as specified in the ROD was Alternative 5: design, construction, and operation of a treatment system to hydraulically capture and treat plume contaminants, performance monitoring of the CS-20 plume and remedial system, ecological sampling to monitor the impacts of the treatment system on the environment, and institutional controls (AFCEE 2000).

The CS-20 remedial system consists of two extraction wells that began operation on 11 January 2006 at a design extraction rate of 775 gpm (425 gpm at 81EW0001 and 350 gpm at 81EW0002) (**Figure 5-5A**). Extracted groundwater is treated by GAC in the centrally-located HATF and the treated water is returned to the aquifer through reinjection wells, an infiltration trench, and an infiltration gallery. Further details regarding the CS-20 remedial system can be found in the 2012 O&M Plan (AFCEE 2012b).

An ESD was submitted in 2008 to document changes to the selected remedy for CS-20 (AFCEE 2008b). The primary difference between the cleanup strategy identified in the ROD and the final design is that the selected alternative presented in the ROD anticipated that the entire CS-20 plume would be hydraulically captured by the remedial system; however, the final design allowed the groundwater contamination in the downgradient leading edge of CS-20 to reach cleanup levels through natural attenuation instead of through active treatment. A third leading edge extraction well was originally included for CS-20 in the SWOU Wellfield Design (AFCEE 2004) but, due to access issues, was not installed. While analyzing various designs for system performance, effectiveness, property access issues, and other constraints, the final design for CS-20 was developed to meet the RAOs described in Section 5.5.3, while allowing for a relatively small portion of the plume to attenuate naturally.

An ESD for the IRP groundwater plumes was submitted in September 2011 that clarified the inclusion of MNA as a component of the selected remedy, slightly modified the phrasing of the RAOs, and updated the steps to achieve site closure (i.e., the three-step process) (AFCEE 2011b).

5.5.2.4 Basis for Taking Action

The baseline cancer risk calculations in the SWOU RI indicated that unless remedial action is undertaken, future residential exposure to PCE in groundwater may present an excess lifetime cancer risk greater than the acceptable MassDEP threshold of $1x10^{-5}$ and the acceptable EPA range of $1x10^{-4}$ to $1x10^{-6}$. Ecological risks associated with the CS-20 groundwater plume were evaluated during the RI and no significant risk was identified (AFCEE 1999c).

5.5.3 Remedial Actions

The final remedy for the CS-20 plume was determined in the *Final Record of Decision for the CS-4, CS-20, CS-21 and FS-13 Plumes* (AFCEE 2000) which was signed on 18 February 2000.

The RAOs for the CS-20 groundwater plume as presented in the ROD (AFCEE 2000) and modified in the ESD (AFCEE 2011b) are as follows:

- Prevent residential exposure to CS-20 groundwater with PCE concentrations greater than the MCL of 5 µg/L.
- Restore useable groundwaters to their beneficial uses wherever practicable, within a timeframe that is reasonable given the particular circumstances of the site.

5.5.3.1 Remedy Selection and Implementation

The selected remedy for CS-20 groundwater in the ROD (AFCEE 2000) included the following components:

- The design, construction, and operation of a treatment system to hydraulically capture and treat plume contaminants,

- Institutional controls to mitigate exposure to humans from CS-20 groundwater contaminants. In 1999, the Falmouth BOH adopted water well regulations to minimize the risk of exposure to groundwater contamination,
- Engineering controls to mitigate exposure to humans from CS-20 groundwater contaminants. Residents potentially impacted by the plume are connected to a public water supply,
- Plume monitoring, performance monitoring of the treatment system, and ecological sampling to monitor the impacts of the system on the environment, and
- Completion of CERCLA reviews every five years throughout the lifetime of the remedial action.

Since the remedy was selected in 2000, the following changes have occurred:

1) The Wellfield Design (AFCEE 2004) presented the revised plan to treat the four Southwest Plumes (CS-4, CS-20, CS-21, and FS-29) via GAC at a centrally-located treatment plant (HATF) on the MMR. The CS-20 leading edge extraction well originally included in the SWOU Wellfield Design was not installed due to access issues (AFCEE 2008b).

2) The institutional controls described in the ROD were further developed as described in the Southwest Plumes ESD (AFCEE 2008b). The ESD provides a more thorough description of the LUC Program, including a private well verification program that is being instituted for all the MMR groundwater sites.

3) The 2011 ESD for the IRP groundwater plumes (AFCEE 2011b) clarified the inclusion of MNA as a component of the selected remedy for CS-20, slightly modified the phrasing of the RAOs, and added text regarding the MMR three-step process to achieve site closure.

The CS-20 remedial system was installed in 2005 and began operation on 11 January 2006 using two extraction wells at a total flow rate of 775 gpm.

Remedial system performance monitoring data and long-term plume monitoring data collected under the SPEIM/LTM program are used to assess: (i) whether the remedial objectives and system performance metrics are being met; (ii) whether remediation is progressing as expected; and (iii) to identify and assess optimization opportunities. The

data collected under the SPEIM/LTM program are presented to the regulatory agencies through the Technical Update meeting process and documented in annual SLRs.

As part of the LUC process specified in the ROD and subsequent ESD (AFCEE 2000, 2008b), a private well verification survey was completed for the Southwest Plumes (including CS-20) and FS-28 between April 2009 and August 2011 (AFCEE 2012e). This private well verification survey consisted of outreach to 497 parcels. Responses were obtained from 100 percent of the property owners within the LUC area and identified a total of 67 properties associated with CS-20 that have one or more private wells that are used as a non-potable water source. One well used for drinking water was identified. Technical evaluations were completed for each private well to determine the sampling frequency and/or re-evaluation frequencies (if necessary) (AFCEE 2012e). No private wells that were identified present an unacceptable exposure risk from CS-20 groundwater. The private well used as a potable source that was identified will be sampled annually as part of the LUC monitoring program. In the event that new private well information is obtained or plume monitoring data indicate a change to the CSM at CS-20, AFCEC will perform the necessary well determinations at the time the information becomes available.

In addition, between February and July 2013, AFCEC contacted the owners of private wells that were determined to be non-operational or disconnected to confirm that the wells have not been restarted. During this 2013 outreach, AFCEC determined that none of the 49 private wells that were identified during the initial well verification effort as non-operational or disconnected have been returned to service.

The status of non-operational private wells within the CS-20 LUC area will continue to be tracked. AFCEC will distribute a mailing, on an annual basis, to property owners within the LUC area that have non-operational wells for which no technical evaluation could be completed due to lack of known well depths and inability to sample. The intent of the annual mailing is to remind these property owners that they should contact AFCEC for a technical evaluation, which may include sampling, in the event their well is put back into service. In addition to these annual mailings, AFCEC will perform outreach as part

of future Five Year Reviews to each of the property owners requiring confirmation of the non-operational status of their wells (AFCEC 2013a).

5.5.3.2 Remedy Operation & Maintenance

The CS-20 remedial system is operated and maintained under an approved O&M Plan (AFCEE 2012b). The O&M Plan is updated on an annual basis and includes operational requirements, a summary of the operational history of the systems, and details of any system modifications, optimizations, or improvements. While occasional operational issues are identified, these issues have been, and continue to be, addressed in a timely and effective manner such that O&M associated with the remedy is considered effective at achieving the remedy goals. Operational issues are identified in O&M monthly reports and system performance and reliability is reported in the annual SLRs.

The annual SPEIM/LTM/O&M costs associated with ongoing remedial actions at CS-20 are generally consistent with those predicted at the time of remedy selection (with consideration for savings associated with optimization initiatives) and do not indicate potential remedy problems.

5.5.4 Progress Since the Last Five Year Review

Per the EPA guidance document (EPA 2001), this section summarizes the progress made on the specific recommendations and follow-up actions presented in the prior third CERCLA Five Year Review (AFCEE 2008a). For the CS-20 groundwater plume, the recommendations and follow-up actions were:

1) Section 4.1 of the third Five Year Review recommended that a screening level VI evaluation be completed for each IRP groundwater site. The objective of the VI evaluation was to determine if a VI exposure pathway exists at a particular site, and if so, complete a screening level evaluation to determine if VI risk above target levels is likely or unlikely.

2) Section 4.3 of the third Five Year Review recommended that, in order to ensure long term protectiveness, all groundwater sites with off-base plume areas must undergo the well verification process as described in AFCEC's guideline titled *Verification, Decommissioning, and Documentation Guidelines for Private Wells in Areas of Potential Concern* (AFCEE 2008f). It was recommended that this requirement be codified in an ESD for those off-base groundwater sites with RODs that do not currently contain the well verification language as part of the required LUCs. For off-base groundwater sites without final RODs at the time of the third Five Year Review (AV and CS-10), the well verification language should be included in the LUC requirements presented in the Final RODs.

3) The RAOs in the ROD required that the Air Force "prevent or reduce residential exposure". The third Five Year Review recommended that the RAOs be modified to eliminate the word "reduce" to better ensure long-term protectiveness.

Progress since the last Five Year Review against these recommendations and follow-up actions is as follows:

1) A VI evaluation was completed for the 16 IRP groundwater sites at the MMR as documented in the *Final 2011 MMR Vapor Intrusion Evaluation Technical Memorandum* (AFCEE 2012a) including CS-20. The VI evaluation indicated an incomplete pathway for VI at CS-20 and no further monitoring or data collection is needed specific to VI at CS-20. However, as part of the ongoing remedial actions at CS-20, AFCEC will continue to monitor the nature and extent of the CS-20 plume under the SPEIM program and will re-evaluate the VI exposure pathway if conditions change such that VI could be a concern.

2) The *Final Explanation of Significant Differences for CS-4, CS-20, CS-21, FS-13, FS-28, and FS-29 Groundwater Plumes* (AFCEE 2008b) was signed on 26 September 2008 and included the requirement to complete the private well verification portion of the LUCs within three years of the signing of the ESD. This well verification effort was completed in 2011 and concluded that no private wells that were identified present an unacceptable exposure risk from the CS-20

groundwater (AFCEE 2012e). Further details of the well verification process and findings are included in Section 5.5.3.1.

3) The 2011 ESD for the IRP groundwater plumes (AFCEE 2011b) modified the phrasing of the RAOs to remove the word "reduce". The revised RAOs are presented in Section 5.5.3.

5.5.5 Five Year Review Process

5.5.5.1 Data Review

The MMR SPEIM program was developed to monitor plume changes and to ensure the effective operation of the AFCEC groundwater remediation systems at the MMR. These objectives are met through monitoring of selected media (i.e., groundwater, surface water) within and outside the plume boundaries, treatment plant monitoring, and groundwater flow and transport modeling. The data collected under the SPEIM program are continually assessed by a team of on-site professional staff and the results of these assessments are presented to the regulatory agencies initially during Technical Update meetings and then through technical memoranda or project note deliverables, if warranted, based on the results of the data evaluation or to address particular plume issues.

In addition, AFCEC prepares annual SLRs for the groundwater plumes that are being addressed through active treatment. The purpose of these SLRs is to document the results of sampling activities conducted at each plume under the SPEIM program. The SLRs also include: (i) a summary of all major events and optimizations completed at the plume; (ii) O&M-related system performance information such as contaminant mass removal/air emissions, system flow rate summaries, and downtime summaries; and (iii) all relevant technical assessment documentation completed during the annual reporting period as attachments or by reference. The SLRs are provided to the broad stakeholder group for each plume including Federal (EPA) and State (MassDEP, MassDPH) regulatory agencies, town departments (such as the BOHs, Departments of Public Work, Water Departments, and/or Conservation Commissions), affected property

owners, and other interested parties. The SLRs are publically available in the IRP Administrative Record and copies are maintained at the local town libraries.

In addition to the annual SLRs prepared for the Southwest Plumes (including CS-20) during this Five Year Review period (AFCEC 2013c, AFCEE 2012c, 2011d, 2010b, 2009b, 2008g), the following technical deliverables were prepared that assessed system performance or presented the results of optimization evaluations:

- *Final CS-4, CS-20, CS-21 and FS-29 Baseline SPEIM Report* (AFCEE 2008e)
- *Southwest Plumes 2008 Annual SPEIM Data Presentation Project Note* (AFCEE 2008c)
- *Southwest Plumes 2009 Triennial SPEIM Data Presentation Project Note* (AFCEE 2009a)
- *Southwest Plumes 2010 Annual SPEIM Data Presentation Project Note* (AFCEE 2010a)
- *Southwest Plumes 2010 Semiannual SPEIM Data Presentation Project Note* (AFCEE 2011c)
- *Southwest Plumes 2011 Annual SPEIM Data Presentation Project Note* (AFCEE 2011a)
- *Southwest Plumes 2011 Semiannual SPEIM Data Presentation Project Note* (AFCEE 2012d)
- *Southwest Plumes 2012 Triennial SPEIM Data Presentation Project Note* (AFCEC 2012)

While additional details are provided in the documents listed above, the primary findings and conclusions from these system performance evaluations at CS-20 are as follows:

1. The CS-20 remedial system removed approximately 45 lbs of PCE through the treatment of approximately 1.6 billion gallons of groundwater during this Five Year Review period. The CS-20 remedial system has treated approximately 2.4 billion gallons of contaminated groundwater and removed approximately 89 lbs of PCE between system startup (January 2006) and December 2012.

2. A comparison of the CS-20 plume boundary at the start and end of this Five Year Review period (i.e., 2007 versus 2012) is included on **Figure 5-5B**. COC concentration trends at select groundwater monitoring wells are shown in **Figure 5-5C**. The highest COC detection in the CS-20 plume between 2007 and 2012 was PCE at 45.6 μg/L collected from monitoring well 81MW0011B in April 2007. The five highest COC detections at CS-20 in 2007 were for PCE and ranged from 15.2 to 45.6 μg/L. In 2012, the five highest COC detections at CS-20 were for PCE and ranged from 5.7 to 23 μg/L (**Figure 5-5C**).

3. Through a combination of active treatment and natural attenuation, the plume remediation is progressing as expected. A review of the SPEIM data indicate that the plume extent and concentrations are declining as expected, and the restoration timeframe predicted by groundwater modeling at the time of remedy selection (i.e., PCE concentrations decline to less than the MCL by approximately 2030) should be met.

4. Surface water bodies in the vicinity of the CS-20 plume include the kettle pond Deep Pond, which is located near the distal end of the plume, and a small unnamed wetland on the southwestern side of the plume. No VOCs have ever been detected in surface water samples collected from Deep Pond or the small unnamed wetland.

5. A review of data collected at the CS-20 Crooked Pond Sentry Wells indicates that PCE concentrations remain above the MCL, but they are decreasing in the uncaptured leading edge of the CS-20 plume. These sentry wells are located 3,600 ft hydraulically upgradient of the Crooked Pond PWSW, which has well-head treatment installed.

6. Plume monitoring under AFCEC's SPEIM/LTM program should continue at CS-20 to provide the necessary data to manage potential exposure risks, assess remedial progress, and evaluate optimization opportunities.

5.5.5.2 Site Inspections

Refer to Section 3.5.

5.5.5.3 Interviews

Refer to Section 3.6.

5.5.6 Technical Assessment

The technical assessment component of the Five Year Review consists of evaluating the protectiveness of the remedy. The technical assessment is based on EPA guidance provided in Section 4.0 of the Comprehensive Five Year Review Guidance (EPA 2001).

5.5.6.1 Question A: Is the remedy functioning as intended by the decision documents?

Yes, the completion of the ROD in 2000, construction and startup of the remedial system in 2005 and 2006, continued operation of the remedial system, and completion of the well verification/well determination portion of the LUCs in 2011 have resulted in the remedy at CS-20 functioning as intended by the decision documents. The remedial system is performing as expected. Through the combination of the active treatment by the remedial system and natural attenuation processes, groundwater cleanup levels are expected to be achieved within the timeframe approximated in the ROD (i.e., 2030). Operational costs are appropriate for the remedy and a robust optimization program continues with the objective of reducing remedial system operational timeframes, the time to reach remedial goals (e.g., MCLs), and reducing future costs. Monitoring and evaluation activities are continual and well-documented.

5.5.6.2 Question B: Are the exposure assumptions, toxicity data, cleanup levels, and remedial action objectives (RAOs) used at the time of the remedy selection still valid?

Changes in Standards and To-Be Considered: There have been no changes in standards or TBC guidance.

Changes in Exposure Pathways: There have been no changes to exposure pathways or land use of the site that would affect the protectiveness of the remedy. Since the VI exposure pathway was not considered in the RI, a more thorough evaluation has been completed and the VI pathway was found to be incomplete (AFCEE 2012a).

Changes in Toxicity and Other Contaminant Characteristics: There has been a change in the toxicity factors that were in place at the time of the last Five Year Review (i.e., 2007) for the CS-20 groundwater COC, PCE.

The carcinogenic toxicity values for PCE (oral and inhalation) became less conservative, while the non-cancer toxicity values (oral and inhalation) became more conservative but by less than an order of magnitude (EPA 2013). These toxicity changes for PCE did not lead to a change in the MCL of 5 µg/L.

Since the RAOs and risk management decisions associated with CS-20 groundwater are based on the MCL, these changes in toxicity values do not affect the protectiveness of the remedy. However, these updated toxicity values (or values derived from future updates) should be used when performing the residual risk assessment as part of the three-step process to achieve site closure (AFCEE 2011b).

Changes in Risk Assessment Methods: There were no changes in risk assessment methodology.

Review of RAOs: The RAOs developed for the final ROD (AFCEE 2000) and revised in the 2011 ESD (AFCEE 2011b) are appropriate and remain valid.

5.5.6.3 Question C: Has any other information come to light that could call into question the protectiveness of the remedy?

No.

5.5.7 Issues, Recommendations, and Follow-Up Actions

No specific recommendation or follow-up actions have been identified. However, the topic of emerging contaminants should be monitored as it relates to groundwater at the MMR. Specifically for CS-20 groundwater, a sampling and analysis plan shall be submitted to the regulatory agencies to assess the possible presence of 1,4-dioxane.

5.5.8 Protectiveness Statement

The remedy for the CS-20 groundwater plume is protective of human health and the environment. The remedial system is performing as expected. The LUCs are in place and are functioning as intended. Through the combination of the active treatment by the remedial system and natural attenuation processes, groundwater cleanup levels are expected to be achieved within the timeframe approximated in the ROD which was considered reasonable given the particular circumstances of the site.

5.5.9 References

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5.6 CHEMICAL SPILL-21 (CS-21) GROUNDWATER

The CS-21 plume is a dissolved-phase groundwater plume (**Figure 5-6A**) that is defined by the extent of groundwater containing the CS-20 COC, TCE, at concentrations exceeding the federal MCL of 5 µg/L.

5.6.1 Site Chronology

1998: The CS-21 plume was discovered during the RI (AFCEE 1999c).

1999: The feasibility study was completed in June 1999 (AFCEE 1999b) and the proposed plan was released to the public in June 1999 (AFCEE 1999a).

2000: ROD finalized (AFCEE 2000).

2004: Completion of the final wellfield design consisting of four CS-21 extraction wells that were installed as part of the Southwest Plumes remedial system, which was designed to collectively remediate the CS-4, CS-20, CS-21, and FS-29 groundwater plumes (AFCEE 2004) (**Figure 5-6A**).

2006: Remedy in place was achieved in September 2006 with the startup of the CS-21 treatment system (AFCEE 2008d).

2008: An ESD was prepared to further describe the institutional controls associated with the remedy (AFCEE 2008b).

2011: An ESD was prepared that clarified the inclusion of MNA as a component of the selected remedy, slightly modified the phrasing of the RAOs, and added text regarding the MMR three-step process to achieve site closure (AFCEE 2011b).

5.6.2 Background

5.6.2.1 History of Contamination

The CS-21 plume is detached from its source area which remains unidentified. It is speculated that contamination was released at the ground surface from a spill or release on the MMR, migrated through the vadose zone, and entered the groundwater at the water table. The dissolved phase contamination was then carried downgradient in groundwater in a south-southwesterly direction.

5.6.2.2 Physical Characteristics, Land and Resource Use

Based on the most recent groundwater monitoring data collected in 2012, the CS-21 plume is approximately 7,000 ft long, has a maximum width of approximately 1,300 ft, and is up to 180 ft thick in the aquifer (**Figure 5-6A**). The footprint of the CS-21 plume was approximately 228 acres in 2007, and was approximately 135 acres in 2012 (**Figure 5-6B**).

The land above the northern portion of the CS-21 plume is undeveloped woodlands used for recreational purposes (hiking, biking, hunting, etc.) within the CWMA, which is managed by the MDFW (**Figure 5-6A**). The land above the southern portion of the CS-21 plume is residential and recreational (Ballymeade Golf Course). The Ballymeade Country Club has two private irrigation wells (69IG0015 and 69IG0016) located near the CS-21 plume. TCE has been detected in the irrigation wells when sampled in the past.

The eastern portion of the CS-21 plume is located within a broad, flat, gently sloping glacial outwash plain. The western portion of the plume travels into a hummocky north-south trending ridge of moraine glacial deposits. Within the footprint of the plume, the maximum and minimum ground surface elevations are 170 ft msl and 80 ft msl, respectively.

5.6.2.3 Initial Responses

A summary of the initial responses is as follows:

Non-CERCLA Actions: None.

CERCLA Actions:

CS-21 Groundwater Plume: Following the 1998 RI (AFCEE 1999c), a feasibility study was completed in 1999 (AFCEE 1999b). A proposed plan was released to the public in June 1999 (AFCEE 1999a) to solicit comments on the preferred alternative (Alternative 11). The selected remedy for CS-21 as specified in the ROD was Alternative 11: design, construction, and operation of a treatment system to hydraulically capture and treat plume contaminants, performance monitoring of the CS-21 plume and remedial system, ecological sampling to monitor the impacts of the treatment system on the environment, and institutional controls (AFCEE 2000).

The CS-21 remedial system consists of four extraction wells (82EW0001 through 82EW0004) that began operation on 11 September 2006 at a design extraction rate of 1,400 gpm (**Figure 5-6A**). Extracted groundwater is treated by GAC in the centrally-located HATF and the treated water is returned to the aquifer through reinjection wells, an infiltration trench, and an infiltration gallery. Further details regarding the CS-21 remedial system can be found in the 2012 O&M Plan (AFCEE 2012b).

An ESD for the IRP groundwater plumes was submitted in September 2011 that clarified the inclusion of MNA as a component of the selected remedy, slightly modified the phrasing of the RAOs, and updated the steps to achieve site closure (i.e., the three-step process) (AFCEE 2011b).

5.6.2.4 Basis for Taking Action

The baseline cancer risk calculations in the SWOU RI indicated that unless remedial action is undertaken, future residential exposure to TCE in groundwater may present an excess lifetime cancer risk greater than the acceptable MassDEP threshold of $1x10^{-5}$ and the acceptable EPA range of $1x10^{-4}$ to $1x10^{-6}$. Ecological risks associated with the CS-21 groundwater plume were evaluated during the RI and no significant risk was identified (AFCEE 1999c).

5.6.3 Remedial Actions

The final remedy for the CS-21 plume was determined in the *Final Record of Decision for the CS-4, CS-20, CS-21 and FS-13 Plumes* (AFCEE 2000) which was signed on 18 February 2000.

The RAOs for the CS-21 groundwater plume as presented in the ROD (AFCEE 2000) and modified in the ESD (AFCEE 2011b) are as follows:

- Prevent residential exposure to CS-21 groundwater with TCE concentrations greater than the MCL of 5 μg/L.
- Restore useable groundwaters to their beneficial uses wherever practicable, within a timeframe that is reasonable given the particular circumstances of the site.

5.6.3.1 <u>Remedy Selection and Implementation</u>

The selected remedy for CS-21 groundwater in the ROD (AFCEE 2000) included the following components:

- The design, construction, and operation of a treatment system to hydraulically capture and treat plume contaminants.
- Institutional controls to mitigate exposure to humans from CS-21 groundwater contaminants. In 1999, the Falmouth BOH adopted water well regulations to minimize the risk of exposure to groundwater contamination.
- Engineering controls to mitigate exposure to humans from CS-21 groundwater contaminants. Residents potentially impacted by the plume are connected to a public water supply.
- Plume monitoring, performance monitoring of the treatment system, and ecological sampling to monitor the impacts of the system on the environment.
- Completion of CERCLA reviews every five years throughout the lifetime of the remedial action.

Since the remedy was selected in 2000, the following changes have occurred:

1) The Wellfield Design (AFCEE 2004) presented the revised plan to treat the four Southwest Plumes (CS-4, CS-20, CS-21, and FS-29) via GAC at a centrally-located treatment plant (HATF) on the MMR.

2) The institutional controls described in the ROD were further developed as described in the Southwest Plumes ESD (AFCEE 2008b). The ESD provides a more thorough description of the LUC program, including a private well verification program that is being instituted for all the MMR groundwater sites.

3) The 2011 ESD for the IRP groundwater plumes (AFCEE 2011b) clarified the inclusion of MNA as a component of the selected remedy for CS-21, slightly modified the phrasing of the RAOs, and added text regarding the MMR three-step process to achieve site closure.

The CS-21 remedial system was installed in 2006 and began operation on 11 September 2006 using four extraction wells at a total flow rate of 1,400 gpm.

Remedial system performance monitoring data and long-term plume monitoring data collected under the SPEIM/LTM program are used to assess: (i) whether the remedial objectives and system performance metrics are being met; (ii) whether remediation is progressing as expected; and (iii) to identify and assess optimization opportunities. The data collected under the SPEIM/LTM program are presented to the regulatory agencies through the Technical Update meeting process and documented in annual SLRs.

As part of the LUC process specified in the ROD and subsequent ESD (AFCEE 2000, 2008b), a private well verification survey was completed for the Southwest Plumes (including CS-21) and FS-28 between April 2009 and August 2011 (AFCEE 2012f). This private well verification survey consisted of outreach to 497 parcels. Responses were obtained from 100 percent of the property owners within the LUC area and identified a total of 16 properties (including the Ballymeade Golf Course) associated with CS-21 that have one or more private wells that are used as a non-potable water source. Technical evaluations were completed for each private well to determine the sampling frequency and/or re-evaluation frequencies (if necessary). No private wells that were identified present an unacceptable exposure risk from CS-21 groundwater.

In addition, between February and July 2013, AFCEC contacted the owners of private wells that were determined to be non-operational or disconnected to confirm that these wells have not been restarted. During this 2013 outreach, AFCEC determined that one of the nine private wells that were identified during the initial well verification effort as non-operation or disconnected had been returned to service for outdoor uses. A technical evaluation was completed for this private well and based upon a review of SPEIM data and private well sampling data there is no current risk of exposure to CS-21 groundwater through the intermittent use of this private well for outdoor purposes. The technical evaluation for the private well that was restarted in 2013 is included in **Appendix D**.

The status of non-operational private wells within the CS-21 LUC area will continue to be tracked. AFCEC will distribute a mailing, on an annual basis, to property owners within the LUC area that have non-operational wells for which no technical evaluation could be completed due to lack of known well depths and inability to sample. The intent of the annual mailing is to remind these property owners that they should contact AFCEC for a technical evaluation, which may include sampling, in the event their well is put back into service. In addition to these annual mailings, AFCEC will perform outreach as part of future Five Year Reviews to each of the property owners requiring confirmation of the non-operational status of their wells (AFCEC 2013a)

5.6.3.2 Remedy Operation & Maintenance

The CS-21 remedial system is operated and maintained under an approved O&M Plan (AFCEE 2012b). The O&M Plan is updated on an annual basis and includes operational requirements, a summary of the operational history of the systems, and details of any system modifications, optimizations, or improvements. While occasional operational issues are identified, these issues have been, and continue to be, addressed in a timely and effective manner such that O&M associated with the remedy is considered effective at achieving the remedy goals. Operational issues are identified in O&M monthly reports and system performance and reliability is reported in the annual SLRs.

The annual SPEIM/LTM/O&M costs associated with ongoing remedial actions at CS-21 are generally consistent with those predicted at the time of remedy selection (with consideration for savings associated with optimization initiatives) and do not indicate potential remedy problems.

5.6.4 Progress Since the Last Five Year Review

Per the EPA guidance document (EPA 2001), this section summarizes the progress made on the specific recommendations and follow-up actions presented in the prior third CERCLA Five Year Review (AFCEE 2008a). For the CS-21 groundwater plume, the recommendations and follow-up actions were:

1) Section 4.1 of the third Five Year Review recommended that a screening level VI evaluation be completed for each IRP groundwater site. The objective of the VI evaluation was to determine if a VI exposure pathway exists at a particular site, and if so, complete a screening level evaluation to determine if VI risk above target levels is likely or unlikely.

2) Section 4.3 of the third Five Year Review recommended that, in order to ensure long term protectiveness, all groundwater sites with off-base plume areas must undergo the well verification process as described in AFCEC's guideline titled *Verification, Decommissioning, and Documentation Guidelines for Private Wells in Areas of Potential Concern* (AFCEE 2008f). It was recommended that this requirement be codified in an ESD for those off-base groundwater sites with RODs that do not currently contain the well verification language as part of the required LUCs. For off-base groundwater sites without final RODs at the time of the third Five Year Review (AV and CS-10), the well verification language should be included in the LUC requirements presented in the Final RODs.

3) The RAOs in the ROD required that the Air Force "prevent or reduce residential exposure". The third Five Year Review recommended that the RAOs be modified to eliminate the word "reduce" to better ensure long-term protectiveness.

Progress since the last Five Year Review against these recommendations and follow-up actions is as follows:

1) A VI evaluation was completed for the 16 IRP groundwater sites at the MMR as documented in the *Final 2011 MMR Vapor Intrusion Evaluation Technical Memorandum* (AFCEE 2012a) including CS-21. The VI evaluation indicated an incomplete pathway for VI at CS-21 and no further monitoring or data collection is needed specific to VI at CS-21. However, as part of the ongoing remedial actions at CS-21, AFCEC will continue to monitor the nature and extent of the CS-21 plume under the SPEIM program and will re-evaluate the VI exposure pathway if conditions change such that VI could be a concern.

2) The Final Explanation of Significant Differences for CS-4, CS-20, CS-21, FS-13, FS-28, and FS-29 Groundwater Plumes (AFCEE 2008b) was signed on 26 September 2008 and included the requirement to complete the private well verification portion of the LUCs within three years of the signing of the ESD. This well verification effort was completed in 2011 and concluded that no private wells that were identified present an unacceptable exposure risk from the CS-21 groundwater (AFCEE 2012f). Further details of the well verification process and findings are included in Section 5.6.3.1.

3) The 2011 ESD for the IRP groundwater plumes (AFCEE 2011b) modified the phrasing of the RAOs to remove the word "reduce". The revised RAOs are presented in Section 5.6.3.

5.6.5 Five Year Review Process

5.6.5.1 Data Review

The MMR SPEIM program was developed to monitor plume changes and to ensure the effective operation of the AFCEC groundwater remediation systems at the MMR. These objectives are met through monitoring of selected media (i.e., groundwater, surface water) within and outside the plume boundaries, treatment plant monitoring, and

groundwater flow and transport modeling. The data collected under the SPEIM program are continually assessed by a team of on-site professional staff and the results of these assessments are presented to the regulatory agencies initially during Technical Update meetings and then through technical memoranda or project note deliverables, if warranted, based on the results of the data evaluation or to address particular plume issues.

In addition, AFCEC prepares annual SLRs for the groundwater plumes that are being addressed through active treatment. The purpose of these SLRs is to document the results of sampling activities conducted at each plume under the SPEIM program. The SLRs also include: (i) a summary of all major events and optimizations completed at the plume; (ii) O&M-related system performance information such as contaminant mass removal/air emissions, system flow rate summaries, and downtime summaries; and (iii) all relevant technical assessment documentation completed during the annual reporting period as attachments or by reference. The SLRs are provided to the broad stakeholder group for each plume including Federal (EPA) and State (MassDEP, MassDPH) regulatory agencies, town departments (such as the BOHs, Departments of Public Work, Water Departments, and/or Conservation Commissions), affected property owners, and other interested parties. The SLRs are publically available in the IRP Administrative Record and copies are maintained at the local town libraries.

In addition to the annual SLRs prepared for the Southwest Plumes (including CS-21) during this Five Year Review period (AFCEC 2013b, AFCEE 2012d, 2011d, 2010b, 2009b, 2008g), the following technical deliverables were prepared that assessed system performance or presented the results of optimization evaluations:

- *Final CS-4, CS-20, CS-21 and FS-29 Baseline SPEIM Report* (AFCEE 2008e)
- *Southwest Plumes 2008 Annual SPEIM Data Presentation Project Note* (AFCEE 2008c)
- *Southwest Plumes 2009 Triennial SPEIM Data Presentation Project Note* (AFCEE 2009a)
- *CS-21 Direct Push Data Presentation Project Note* (AFCEE 2010c)

- *Southwest Plumes 2010 Annual SPEIM Data Presentation Project Note* (AFCEE 2010a)
- *Southwest Plumes 2010 Semiannual SPEIM Data Presentation Project Note* (AFCEE 2011c)
- *Southwest Plumes 2011 Annual SPEIM Data Presentation Project Note* (AFCEE 2011a)
- *Southwest Plumes 2011 Semiannual SPEIM Data Presentation Project Note* (AFCEE 2012e)
- *Chemical Spill-21 Remedial System Optimization Evaluation Project Note* (AFCEE 2012c)
- *Southwest Plumes 2012 Triennial SPEIM Data Presentation Project Note* (AFCEC 2012)

While additional details are provided in the documents listed above, the primary findings and conclusions from these system performance evaluations at CS-21 are as follows:

1. The CS-21 remedial system removed approximately 106 lbs of TCE through the treatment of approximately 2.8 billion gallons of groundwater during this Five Year Review period. The CS-21 remedial system has treated approximately 3.6 billion gallons of contaminated groundwater and removed approximately 155 lbs of TCE between system startup (September 2006) and December 2012.

2. A comparison of the CS-21 plume boundary at the start and end of this Five Year Review period (i.e., 2007 versus 2012) is included on **Figure 5-6B**. COC concentration trends at select groundwater monitoring wells are shown in **Figure 5-6C**. The highest COC detection in the CS-21 plume between 2007 and 2012 was TCE at an estimated concentration of 98 µg/L collected from direct push boring 82DP0004 (located adjacent to monitoring well 69MW1506A,B) in June 2009. The five highest COC detections at CS-21 in 2007 were for TCE and ranged from 22.3 to 59.4 µg/L. In 2012, the five highest COC detections at CS-21 were for TCE and ranged from 19 to 79 µg/L (**Figure 5-6C**).

3. Through a combination of active treatment and natural attenuation, the plume remediation is progressing as expected. A review of the SPEIM data indicate that the plume extent and concentrations are declining as expected, and the restoration timeframe predicted by groundwater modeling at the time of remedy selection (i.e., TCE concentrations decline to less than the MCL by approximately 2025) should be met.

4. A remedial system optimization assessment completed in 2010 and 2011 provided evidence that the operation of 82EW0004 was successful in remediating the portion of the plume it was intended to address (AFCEE 2012c). Therefore, extraction well 82EW0004 was shut down on 23 June 2010 with regulatory agency concurrence. In addition, flow rates were reduced at CS-21 extraction wells 82EW0002 and 82EW0003 by 174 gpm each.

5. In 2002 the MassDPH evaluated potential health concerns associated with TCE concentrations detected at Ballymeade Country Club Irrigation wells 69IG0015 and 69IG0016 (MassDPH 2002). Results of the MassDPH assessment indicated that the use of irrigation water from 69IG0015 and 69IG0016 with TCE at the assumed maximum concentration (20 µg/L based on groundwater model predictions) did not result in health concerns for the exposure assumptions considered. TCE concentrations did slightly exceed 20 µg/L during March (21.2 µg/L at 69IG0015) and April 2007 (22.3 µg/L at 69IG0015 and 20.2 µg/L at 69IG0016), but declined quickly afterwards; TCE has not been detected at a concentration above the MCL of 5 µg/L at 69IG0015 or 69IG0016 since 2008. TCE was not detected in 2012 at 69IG0016, and was at an estimated concentration below the reporting limit of 1 µg/L at 69IG0015. Golf course irrigation wells (69IG0015 and 69IG0016) located at the Ballymeade Country Club will continue to be monitored under AFCEC's LUC Program (AFCEE 2012f).

6. Plume monitoring under AFCEC's SPEIM/LTM program should continue at CS-21 to provide the necessary data to manage potential exposure risks, assess remedial progress, and evaluate optimization opportunities.

5.6.5.2 Site Inspections

Refer to Section 3.5.

5.6.5.3 Interviews

Refer to Section 3.6.

5.6.6 Technical Assessment

The technical assessment component of the Five Year Review consists of evaluating the protectiveness of the remedy. The technical assessment is based on EPA guidance provided in Section 4.0 of the Comprehensive Five Year Review Guidance (EPA 2001).

5.6.6.1 Question A: Is the remedy functioning as intended by the decision documents?

Yes, the completion of the ROD in 2000, construction and startup of the remedial system in 2006, continued operation of the remedial system, and completion of the well verification/well determination portion of the LUCs in 2011 have resulted in the remedy at CS-21 functioning as intended by the decision documents. The remedial system is performing as expected. Through the combination of the active treatment by the remedial system and natural attenuation processes, groundwater cleanup levels are expected to be achieved within the timeframe approximated in the ROD (i.e., by 2025). Operational costs are appropriate for the remedy and a robust optimization program continues with the objective of reducing remedial system operational timeframes, the time to reach remedial goals (e.g., MCLs), and reducing future costs. Monitoring and evaluation activities are continual and well-documented.

5.6.6.2 Question B: Are the exposure assumptions, toxicity data, cleanup levels, and remedial action objectives (RAOs) used at the time of the remedy selection still valid?

Changes in Standards and To-Be Considered: There have been no changes in standards or TBC guidance.

Changes in Exposure Pathways: There have been no changes to exposure pathways or land use of the site that would affect the protectiveness of the remedy. Since the VI exposure pathway was not considered in the RI, a more thorough evaluation has been completed and the VI pathway was found to be incomplete (AFCEE 2012a).

Changes in Toxicity and Other Contaminant Characteristics: There has been a change in the toxicity factors that were in place at the time of the last Five Year Review (i.e., 2007) for the CS-21 groundwater COC, TCE.

The carcinogenic toxicity values for TCE (oral and inhalation) and oral non-cancer toxicity value became less conservative, while the inhalation non-cancer toxicity value is now 17.5 times more conservative. TCE was classified as a mutagen by EPA in November 2011 (EPA 2013). This means that when performing risk calculations, the TCE toxicity values need to be multiplied by adjustment factors to address the vulnerability of earlier aged receptors. These toxicity changes for TCE did not lead to a change in the MCL of 5 μg/L.

As discussed in Section 5.6.5.1, TCE has been detected in groundwater sampled from two golf course irrigation wells located near the CS-21 plume. However, based on the most recent sampling conducted in 2012, TCE is no longer detected in one irrigation well and at a concentration below the reporting limit of 1 μg/L (and therefore below the MCL of 5 μg/L) in the other irrigation well. In 2002, MassDPH evaluated potential health concerns associated with these irrigation wells and concluded that TCE concentrations up to 20 μg/L in groundwater at these wells should not result in health concerns for the exposure assumptions considered. It is acknowledged that this 2002 evaluation used less conservative toxicity factors than are currently available for TCE, but since the current concentration of TCE detected at these wells are well below the MCL, no health concerns

should result from the continued use of these irrigation wells.

Since the RAOs and risk management decisions associated with CS-21 groundwater (including use of the golf course irrigation wells) are currently based on the MCL for TCE, these changes in toxicity values do not affect the protectiveness of the remedy. However, the updated toxicity values for TCE (or values derived from future updates) should be used when performing the residual risk assessment as part of the three-step process to achieve site closure (AFCEE 2011b). In addition, if the TCE concentration at either of the golf course irrigation wells increases above the MCL in the future, the evaluation conducted by MassDPH in 2002 should be updated using the most current toxicity information to determine whether use of these wells could result in health concerns.

<u>Changes in Risk Assessment Methods</u>: There were no changes in risk assessment methodology.

<u>Review of RAOs</u>: The RAOs developed for the final ROD (AFCEE 2000) and revised in the 2011 ESD (AFCEE 2011b) are appropriate and remain valid.

5.6.6.3 <u>Question C: Has any other information come to light that could call into question the protectiveness of the remedy?</u>

No.

5.6.7 Issues, Recommendations, and Follow-Up Actions

No specific recommendation or follow-up actions have been identified. However, the topic of emerging contaminants should be monitored as it relates to groundwater at the MMR. Specifically for CS-21 groundwater, a sampling and analysis plan shall be submitted to the regulatory agencies to assess the possible presence of 1,4-dioxane.

5.6.8 Protectiveness Statement

The remedy for the CS-21 groundwater plume is protective of human health and the environment. The remedial system is performing as expected. The LUCs are in place and are functioning as intended. Through the combination of the active treatment by the remedial system and natural attenuation processes, groundwater cleanup levels are expected to be achieved within the timeframe approximated in the ROD which was considered reasonable given the particular circumstances of the site.

5.6.9 References

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5.7 CHEMICAL SPILL-23 (CS-23) GROUNDWATER

The CS-23 plume is a dissolved-phase groundwater plume that is defined as the extent of groundwater containing TCE at concentrations exceeding its MCL of 5 µg/L. The remaining COC, carbon tetrachloride (CCl_4), is detected sporadically at concentrations near its MCL of 5 µg/L, and is generally co-located with the TCE contamination.

5.7.1 Site Chronology

2002: The CS-23 plume was discovered during the Southwest Plumes pre-design investigation (AFCEE 2003).

2003-2004: Completion of the RI (AFCEE 2005).

2006: The feasibility study was completed (AFCEE 2006c) and the proposed plan was released to the public (AFCEE 2006b). The wellfield design (AFCEE 2006a) was completed which consisted of two extraction wells and two infiltration trenches that began operation in December 2006 (AFCEE 2008b).

2007: ROD finalized (AFCEE 2007).

2011: An ESD was prepared that clarified the inclusion of MNA as a component of the selected remedy, slightly modified the phrasing of the RAOs, and added text regarding the MMR three-step process to achieve site closure (AFCEE 2011b).

5.7.2 Background

5.7.2.1 History of Contamination

The CS-23 plume is detached from its source area which remains unidentified. It is speculated that contamination was released at the ground surface from a spill or release on the MMR, migrated through the vadose zone, and entered groundwater at the water table. The dissolved phase contamination was then carried downgradient in groundwater in a southwesterly direction.

5.7.2.2 Physical Characteristics, Land and Resource Use

Based on the most recent groundwater monitoring data collected in 2012, the CS-23 plume is approximately 5,600 ft long, has a maximum width of approximately 950 ft, and is up to 100 ft thick in the aquifer (**Figure 5-7A**). The footprint of the CS-23 plume was approximately 190 acres in 2007, and was approximately 175 acres in 2012 (**Figure 5-7B**).

The area above the on-base portions of the CS-23 plume consists primarily of a housing area operated by the USCG and four schools controlled by the Town of Bourne (one of which is actively used). The land above the relatively small portion of the CS-23 plume that is off-base is undeveloped woodlands used for recreational purposes (hiking, biking, hunting, etc.), and is managed by the MDFW (**Figure 5-7A**).

The eastern portion of the CS-23 plume is located within a broad, flat, gently sloping glacial outwash plain. The western portion of the plume travels into a hummocky north-south trending ridge of moraine glacial deposits. Within the footprint of the plume, the maximum and minimum ground surface elevations are 206 ft msl and 52 ft msl, respectively.

5.7.2.3 Initial Responses

A summary of the initial responses is as follows:

Non-CERCLA Actions:

None.

CERCLA Actions:

CS-23 Groundwater Plume: Following the 2005 CS-23 RI (AFCEE 2005), a feasibility study was completed in 2006 (AFCEE 2006c). AFCEE began designing a remedial system to prevent further off-base migration of the CS-23 plume concurrently with the feasibility study. A proposed plan was released to the public in June 2006 (AFCEE

2006b) to solicit comments on the preferred alternative (Alternative 3). The selected remedy for CS-23 as specified in the ROD was Alternative 3; continued operation and optimization of the existing remedial system, performance monitoring of the CS-23 plume and remedial system, and LUCs (AFCEE 2007).

The final design for the CS-23 remedial system consisted of two extraction wells (27EW0007 and 27EW0008), which were installed concurrently with a new LF-1 extraction well (27EW0006) (AFCEE 2006a). The extracted groundwater from the extraction wells in the southern portion of LF-1 (27EW0002 and 27EW0006) is combined with the extracted groundwater from 27EW0007 and 27EW0008, treated at the HATF by GAC, and is then returned to the aquifer through two infiltration trenches. The HATF was constructed as part of the remedial action for the CS-4, CS-20, CS-21, and FS-29 plumes (AFCEE 2008b). The CS-23 remedial system began operation on 05 December 2006 with two extraction wells (27EW0007 and 27EW0008) at a design extraction rate of 700 gpm. Further details regarding the LF-1/CS-23 HATF remedial system can be found in the 2012 O&M Plan (AFCEE 2012c).

An ESD for the IRP groundwater plumes was submitted in September 2011 that clarified the inclusion of MNA as a component of the selected remedy, slightly modified the phrasing of the RAOs, and updated the steps to achieve site closure (i.e., the three-step process) (AFCEE 2011b).

5.7.2.4 <u>Basis for Taking Action</u>

The baseline cancer risk calculations in the CS-23 RI indicated that unless remedial action is undertaken, future residential exposure to the CS-23 COCs in groundwater may present an excess lifetime cancer risk greater than the acceptable MassDEP threshold of $1x10^{-5}$ and the acceptable EPA range of $1x10^{-4}$ to $1x10^{-6}$ (AFCEE 2005). Ecological risks associated with the CS-23 groundwater plume were not evaluated because the CS-23 plume is not discharging to any surface water bodies (AFCEE 2007). It is noted that ecological monitoring continues in order to assess hydraulic effects to a nearby

wetland and vernal pool due to the operation of the expanded remedial system (refer to Sections 5.7.4 and 5.7.5).

5.7.3 Remedial Actions

The final remedy for the CS-23 plume was determined in the *Final Record of Decision for the CS-23 Groundwater* (AFCEE 2007) which was signed on 28 September 2007.

The RAOs for the CS-23 groundwater plume as presented in the ROD (AFCEE 2007) and modified in the ESD (AFCEE 2011b) are as follows:

- Prevent residential exposure to CS-23 groundwater with TCE concentrations greater than the MCL of 5 μg/L.
- Prevent residential exposure to CS-23 groundwater with CCl_4 concentrations greater than the MCL of 5 μg/L.
- Restore useable groundwaters to their beneficial uses wherever practicable, within a timeframe that is reasonable given the particular circumstances of the site.
- Prevent exposure to CS-23 groundwater for human receptors under non-residential use scenarios (including dermal contact, ingestion, and inhalation), unless shown that such use does not present a carcinogenic risk in excess of the EPA target risk range of 10^{-4} to 10^{-6} or present a non-carcinogenic hazard index greater than 1.0.

5.7.3.1 Remedy Selection and Implementation

The selected remedy for CS-23 groundwater in the ROD (AFCEE 2007) included the following components:

- Continued operation and optimization of the existing CS-23 ETI system (two extraction wells and two infiltration trenches) and treatment via GAC.
- Implementation of LUCs for the CS-23 groundwater selected remedy with the performance objectives of:
    - Prevent access to or use of the groundwater from the CS-23 plume until the groundwater no longer poses an unacceptable risk, and
    - Maintain the integrity of the current or future remedial or monitoring system such as the treatment systems and monitoring wells.
- Chemical and hydraulic monitoring of the plume, as long as active remediation continues, and chemical monitoring of the plume until the RAOs are met.

- Completion of CERCLA reviews every five years throughout the lifetime of the remedial action.

Since the groundwater remedy was selected in 2007, the following changes have occurred: the 2011 ESD for the IRP groundwater plumes (AFCEE 2011b) clarified the inclusion of MNA as a component of the selected remedy for CS-23, slightly modified the phrasing of the RAOs, and added text regarding the MMR three-step process to achieve site closure.

The selected remedy presented in the ROD consisted of two CS-23 extraction wells which began operation on 05 December 2006.

Remedial system performance monitoring data and long-term plume monitoring data collected under the SPEIM/LTM program are used to assess: (i) whether the remedial objectives and system performance metrics are being met; (ii) whether remediation is progressing as expected; and (iii) to identify and assess optimization opportunities. The data collected under the SPEIM/LTM program are presented to the regulatory agencies through the Technical Update Meeting process and documented in annual SLRs.

The close proximity of the LF-1 and CS-23 plumes and remedial systems warrant that the LF-1 and CS-23 SPEIM programs be combined. Therefore, data collection, data assessment, groundwater modeling, and reporting are performed jointly under a combined LF-1/CS-23 SPEIM program.

As part of the LUC process specified in the ROD (AFCEE 2007), a private well verification survey was completed for the LF-1 and CS-23 plumes between November 2008 and August 2010. There were no private wells identified on properties within the CS-23 LUC area (AFCEE 2011d). In the event that new private well information is obtained or plume monitoring data indicate a change to the CSM at CS-23, AFCEC will perform the necessary well determinations at the time the information becomes available.

5.7.3.2 Remedy Operation & Maintenance

The CS-23 remedial system is operated and maintained under an approved O&M Plan (AFCEE 2012c). The O&M Plan is updated on an annual basis and includes operational requirements, a summary of the operational history of the systems, and details of any system modifications, optimizations, or improvements. While occasional operational issues are identified, these issues have been, and will continue to be, addressed in a timely and effective manner such that O&M associated with the remedy is considered effective at achieving the remedy goals. Operational issues are identified in O&M monthly reports and system performance and reliability is reported in the annual SLRs.

The annual SPEIM/LTM/O&M costs associated with ongoing remedial actions at CS-23 are generally consistent with those predicted at the time of remedy selection (with consideration for savings associated with optimization initiatives) and do not indicate potential remedy problems.

5.7.4 Progress Since the Last Five Year Review

Per the EPA guidance document (EPA 2001), this section summarizes the progress made on the specific recommendations and follow-up actions presented in the prior third CERCLA Five Year Review (AFCEE 2008a). For the CS-23 groundwater plume, the recommendations and follow-up actions were:

1) Section 4.1 of the third Five Year Review recommended that a screening level VI evaluation be completed for each IRP groundwater site. The objective of the VI evaluation was to determine if a VI exposure pathway exists at a particular site, and if so, complete a screening level evaluation to determine if VI risk above target levels is likely or unlikely.

2) Section 4.3 of the third Five Year Review recommended that, in order to ensure long term protectiveness, all groundwater sites with off-base plume areas must undergo the well verification process as described in AFCEC's guideline titled *Verification, Decommissioning, and Documentation Guidelines for Private Wells*

in Areas of Potential Concern (AFCEE 2008d). It was recommended that this requirement be codified in an ESD for those off-base groundwater sites with RODs that do not currently contain the well verification language as part of the required LUCs. For off-base groundwater sites without final RODs at the time of the third Five Year Review (AV and CS-10), the well verification language should be included in the LUC requirements presented in the final RODs.

3) The third Five Year Review recommended continuing to monitor the wetland and vernal pool near LF-1/CS-23 for potential ecological impacts associated with the surface water drawdown.

Progress since the last Five Year Review against these recommendations and follow-up actions is as follows:

1) A VI evaluation was completed for the 16 IRP groundwater sites at the MMR as documented in the *Final 2011 MMR Vapor Intrusion Evaluation Technical Memorandum* (AFCEE 2012a) including CS-23. The VI evaluation indicated an incomplete pathway for VI at CS-23 and no further monitoring or data collection is needed specific to VI at CS-23. However, as part of the ongoing remedial actions at CS-23, AFCEC will continue to monitor the nature and extent of the CS-23 plume under the SPEIM program and will re-evaluate the VI exposure pathway if conditions change such that VI could be a concern.

2) The final remedy for CS-23 plume was determined in the *Final Record of Decision for the CS-23 Groundwater* (AFCEE 2007) which was signed on 28 September 2007 and included the requirement to complete the private well verification portion of the LUCs within three years of the signing of the ROD. This well verification effort was completed in 2010 and concluded that there were no private wells identified on properties within the CS-23 LUC area (AFCEE 2011d). Further details of the well verification process and findings are included in Section 5.7.3.1.

3) The results of ecological and hydrologic monitoring at the LF-1/CS-23 vernal pools and wetlands indicate that while the water levels have lowered (possibly

due to the operation of the system), the ecosystems, vegetation, and wildlife habitats have not changed significantly between 2007 and 2012 (AFCEE 2012b, 2011a, 2011e, 2010c, 2009b).

5.7.5 Five Year Review Process

5.7.5.1 Data Review

The MMR SPEIM program was developed to monitor plume changes and to ensure the effective operation of the AFCEC groundwater remediation systems at the MMR. These objectives are met through monitoring of selected media (i.e., groundwater, surface water) within and outside the plume boundaries, treatment plant monitoring, and groundwater flow and transport modeling. The data collected under the SPEIM program are continually assessed by a team of on-site professional staff and the results of these assessments are presented to the regulatory agencies initially during Technical Update meetings and then through technical memoranda or project note deliverables, if warranted, based on the results of the data evaluation or to address particular plume issues.

In addition, AFCEC prepares annual SLRs for the groundwater plumes that are being addressed through active treatment. The purpose of these SLRs is to document the results of sampling activities conducted at each plume under the SPEIM program. The SLRs also include: (i) a summary of all major events and optimizations completed at the plume; (ii) O&M-related system performance information such as contaminant mass removal/air emissions, system flow rate summaries, and downtime summaries; and (iii) all relevant technical assessment documentation completed during the annual reporting period as attachments or by reference. The SLRs are provided to the broad stakeholder group for each plume including Federal (EPA) and State (MassDEP, MassDPH) regulatory agencies, town departments (such as the BOHs, Departments of Public Work, Water Departments, and/or Conservation Commissions), affected property owners, and other interested parties. The SLRs are publically available in the IRP Administrative Record and copies are maintained at the local town libraries.

In addition to the annual SLRs prepared for CS-23 during this Five Year Review period (AFCEC 2013a; AFCEE 2012d, 2011c, 2010b, 2009c, 2008e), the following technical deliverables were prepared that assessed system performance, the potential hydrologic and ecological impacts of system operation, and presented the results of optimization evaluations:

- *LF-1/CS-23 2008 Annual SPEIM Data Presentation Project Note* (AFCEE 2008c)
- *LF-1/CS-23 2008 Wetland and Surface Water Ecological Evaluation* (Attachment D of AFCEE 2009c)
- *Final LF-1/CS-23 2007 Plume Update Technical Memorandum* (AFCEE 2009b)
- *LF-1/CS-23 2009 Annual SPEIM Data Presentation Project Note* (AFCEE 2009a)
- *LF-1/CS-23 2009 Wetland and Surface Water Ecological Evaluation Project Note* (AFCEE 2010c)
- *LF-1/CS-23 2010 Annual SPEIM Data Presentation Project Note* (AFCEE 2010a)
- *LF-1/CS-23 2010 Wetland and Surface Water Ecological Evaluation Project Note* (AFCEE 2011e)
- *LF-1/CS-23 2011 Wetland and Surface Water Ecological Evaluation Project Note* (AFCEE 2011a)
- *LF-1/CS-23 2011 Triennial SPEIM Data Presentation Project Note* (AFCEE 2012e)
- *LF-1/CS-23 2012 Wetland and Surface Water Ecological Evaluation Project Note* (AFCEE 2012b)
- *LF-1/CS-23 2012 Annual SPEIM Data Presentation Project Note* (AFCEC 2013b)

While additional details are provided in the documents listed above, the primary findings and conclusions from these system performance evaluations at CS-23 are as follows:

1. The CS-23 extraction wells removed approximately 54 lbs of COCs through the treatment of approximately 1.4 billion gallons of groundwater during this Five Year Review period. The CS-23 extraction wells have removed

approximately 71 lbs of COCs through the treatment of approximately 1.8 billion gallons of groundwater between startup in December 2006 and December 2012.

2. A comparison of the CS-23 plume boundary at the start and end of this Five Year Review period (i.e., 2007 versus 2012) is included on **Figure 5-7B**. COC concentration trends at select groundwater monitoring wells are shown in **Figure 5-7C**. The highest COC detection in the CS-23 plume between 2007 and 2012 was TCE at 32.1 μg/L collected from monitoring well 69MW1706A in February 2007. The five highest COC detections at CS-23 in 2007 were for TCE and ranged from 18.5 to 32.1 μg/L. In 2012, the five highest COC detections at CS-23 were for TCE and ranged from 6.5 to 19 μg/L (**Figure 5-7C**).

3. TCE concentrations in downgradient CS-23 monitoring well 69MW1710A increased from 4.2 μg/L in June 2011 to 12 μg/L in May 2012. This increase is attributed to the migration of contamination that was already hydraulically downgradient of the CS-23 extraction wells at the time of system startup. This zone of contamination is in a relatively small area based on data from nearby monitoring wells, and cleanup goals are expected to be reached through natural attenuation within the aquifer restoration timeframe presented in the ROD (i.e., by approximately 2048).

4. Through a combination of active treatment and natural attenuation, the plume remediation is progressing as expected. A review of the SPEIM data indicate that the plume extent and concentrations are declining as expected, and the restoration timeframe predicted by groundwater modeling at the time of remedy selection (i.e., COC concentrations decline to less than MCLs by approximately 2048) should be met.

5. The results of ecological and hydrologic monitoring at the LF-1/CS-23 vernal pools and wetlands indicate that while the water levels have lowered (possibly

due to the operation of the system), the ecosystems, vegetation, and wildlife habitats have not changed significantly between 2007 and 2012.

6. Plume monitoring under AFCEC's SPEIM/LTM program should continue at CS-23 to provide the necessary data to manage potential exposure risks, assess remedial progress, and evaluate optimization opportunities.

5.7.5.2 Site Inspections

Refer to Section 3.5.

5.7.5.3 Interviews

Refer to Section 3.6.

5.7.6 Technical Assessment

The technical assessment component of the Five Year Review consists of evaluating the protectiveness of the remedy. The technical assessment is based on EPA guidance provided in Section 4.0 of the Comprehensive Five Year Review Guidance (EPA 2001).

5.7.6.1 Question A: Is the remedy functioning as intended by the decision documents?

Yes, the completion of the ROD in 2007, construction and startup of the remedial system in 2006, continued operation of the remedial system, and completion of the well verification/well determination portion of the LUCs in 2010 have resulted in the remedy at CS-23 functioning as intended by the decision documents. The remedial system is performing as expected. Through the combination of the active treatment by the remedial system and natural attenuation processes, groundwater cleanup levels are expected to be achieved within the timeframe approximated in the ROD (i.e., by 2048). Operational costs are appropriate for the remedy and a robust optimization program continues with the objective of reducing remedial system operational timeframes, the time to reach

remedial goals (e.g., MCLs), and reducing future costs. Monitoring and evaluation activities are continual and well-documented.

5.7.6.2 Question B: Are the exposure assumptions, toxicity data, cleanup levels, and remedial action objectives (RAOs) used at the time of the remedy selection still valid?

Changes in Standards and To-Be Considered: There have been no changes in standards or TBC guidance.

Changes in Exposure Pathways: There have been no changes to exposure pathways or land use of the site that would affect the protectiveness of the remedy. It is noted that since the VI exposure pathway was not considered in the RI, a screening evaluation has been completed and the VI pathway was found to be incomplete (AFCEE 2012a).

Changes in Toxicity and Other Contaminant Characteristics: There have been changes in the toxicity factors that were in place at the time of the last Five Year Review (i.e., 2007) for the CS-23 groundwater COCs TCE and CCl_4.

For TCE, the carcinogenic toxicity values (oral and inhalation) and oral non-cancer toxicity value became less conservative, while inhalation non-cancer toxicity value is now 17.5 times more conservative. TCE was classified as a mutagen by EPA in November 2011 (EPA 2013). This means that when performing risk calculations, the TCE toxicity values need to be multiplied by adjustment factors to address the vulnerability of earlier aged receptors. These toxicity changes for TCE did not lead to a change in the MCL of 5 μg/L.

For CCl_4, the carcinogenic toxicity values (oral and inhalation) and oral non-cancer toxicity values became less conservative, while the inhalation non-cancer toxicity value became more conservative but by less than an order of magnitude (EPA 2013). These toxicity changes for CCl_4 did not lead to a change in the MCL of 5 μg/L.

Since the RAOs and risk management decisions associated with CS-23 groundwater are based on MCLs, the changes in toxicity values do not affect the protectiveness of the remedy. However, these updated toxicity values (or values derived from future updates) should be used when performing the residual risk assessment as part of the three-step process to achieve site closure (AFCEE 2011b).

Changes in Risk Assessment Methods: There were no changes in risk assessment methodology.

Review of RAOs: The RAOs developed for the final ROD (AFCEE 2007) and revised in the 2011 ESD (AFCEE 2011b) are appropriate and remain valid.

5.7.6.3 Question C: Has any other information come to light that could call into question the protectiveness of the remedy?

No.

5.7.7 Issues, Recommendations, and Follow-Up Actions

An optimization assessment of the LF-1/CS-23 remedial system should be performed with an updated plume shell to evaluate the performance of the remedial system and assess/update the model-predicted restoration timeframe versus that presented in the ROD.

AFCEC should continue to monitor the wetland and vernal pool near LF-1/CS-23 for potential ecological impacts associated with the surface water drawdown.

A re-evaluation of the extent of the CS-23 plume and LUC area should be completed based on the increase in TCE concentration at monitoring well 69MW1710A which is located hydraulically downgradient of the CS-23 remedial system extraction wells.

In addition, the topic of emerging contaminants should be monitored as it relates to groundwater at the MMR. Specifically for CS-23 groundwater, a sampling and analysis plan shall be submitted to the regulatory agencies to assess the possible presence of 1,4-dioxane.

5.7.8 Protectiveness Statement

The remedy for the CS-23 groundwater plume is protective of human health and the environment. The remedial system is performing as expected. The LUCs are in place and are functioning as intended. Through the combination of the active treatment by the remedial systems and natural attenuation processes, groundwater cleanup levels are expected to be achieved within the timeframe approximated in the ROD which was considered reasonable given the particular circumstances of the site.

5.7.9 References

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5.8 FUEL SPILL-1 (FS-1) GROUNDWATER

The FS-1 site is comprised of two areas of impacted groundwater: the source area groundwater, which is located on-base, and a detached groundwater plume which is located largely off-base (**Figure 5-8A**). The detached plume is defined as the extent of groundwater contaminated with the FS-1 COC, EDB, at concentrations exceeding the MMCL of 0.02 µg/L. The COCs for the source area groundwater are lead, thallium, and toluene (AFCEE 2000). The cleanup standards for the source area COCs are as follows: the EPA Treatment Technique of 15 µg/L for lead in drinking water in distribution systems; the MCL of 2 µg/L for thallium; and the MCL of 1,000 µg/L for toluene.

5.8.1 Site Chronology

1989: Fuel-related compounds, consisting of benzene, toluene, ethylbenzene, and xylene (BTEX) were first reported in groundwater during an SI (AFCEE 2000).

1990: An RI was completed in 1990 to delineate the extent of fuel related compounds in groundwater at, and downgradient of, the source area. At that time no BTEX compounds were detected at wells located downgradient of the source area and it was hypothesized that BTEX compounds, which may have been present in the groundwater downgradient of the source area in the past, had degraded (AFCEE 1999b).

1993: The FS-1 source area monitoring wells were sampled for EDB analysis as part of a base-wide EDB study and no EDB was detected (AFCEE 2000).

1995: Groundwater vertical profiling for BTEX was completed at 20 locations downgradient of the source area and no BTEX compounds were detected (AFCEE 2000).

1997-1998: Additional RI activities were completed along a flow path that had not previously been investigated (AFCEE 1999b), which resulted in the delineation of a dissolved-phase EDB plume that was attributed to past releases at the FS-1 source area.

1999: A feasibility study and proposed plan were completed (AFCEE 1999c, AFCEE 1999a). A pilot study ETD remediation system was installed at the leading edge of the plume to treat groundwater.

2000: The ROD was completed (AFCEE 2000). The final remedy called for continued operation of the pilot study ETD system with the addition of more axial extraction wells.

2003: A final remedy was in place at FS-1 with construction and startup of the final ETD system on 30 September 2003 based on a post-ROD wellfield design (AFCEE 2001).

2011: An ESD was prepared that clarified the inclusion of MNA as a component of the selected remedy, added institutional controls, slightly modified the phrasing of the RAOs, and added text regarding the MMR three-step process to achieve site closure (AFCEE 2011b).

5.8.2 Background

5.8.2.1 History of Contamination

The source of the FS-1 groundwater plume was surficial releases of AVGAS at the Eastern and Western Aircraft Turnaround Areas within the flight line (**Figure 5-8A**). The site was used from 1955 to 1970 to test fuel dump valves on EC-121 Super Constellation aircraft. As part of the tests, fuel was released directly onto the ground. The exact quantity of fuels released onto the ground is unknown. Both the Eastern Aircraft Turnaround and Western Aircraft Turnaround Areas were investigated during the course of the SI (ASI 1995) and RI (AFCEE 1999b). No contaminants were present in the surface or subsurface soils at the FS-1 source area at concentrations that exceeded regulatory standards (AFCEE 2008b). However, fuel-related compounds such as BTEX and various metals were detected in groundwater on-base within 1,000 ft of the Aircraft Turnaround Areas. Only lead, thallium, and toluene were detected at concentrations above their respective MCLs. No EDB has ever been detected in the source area groundwater (AFCEE 2000).

The FS-1 ROD, signed in April 2000, stated that no further action was needed for source area soil contamination (AFCEE 2000). However, an LTM program for lead, thallium, and toluene in source area groundwater was established to confirm that these compounds would not migrate beyond the general vicinity of the FS-1 source area (i.e., area within 1,000 ft of the Eastern and Western Aircraft Turnaround Areas).

Groundwater monitoring data indicate that the FS-1 groundwater plume has fully detached from its source area and there is no evidence that there is a continuing source of contamination to the groundwater plume.

5.8.2.2 Physical Characteristics, Land and Resource Use

Based on the most recent groundwater monitoring data collected in 2012, the main body of the FS-1 EDB plume is approximately 2,700 ft long, up to 700 ft wide, and is approximately 70 ft thick in the aquifer (**Figure 5-8A**). The footprint of the FS-1 plume was approximately 78 acres in 2007 and was approximately 32 acres in 2012 (**Figure 5-8B**).

Land above the FS-1 source area on the MMR is comprised of paved areas of the flight line that are bordered by sparsely vegetated land surface. Land above the FS-1 EDB plume is comprised of undeveloped forested land with wetland bogs (Quashnet bogs) at the most southern, downgradient extent of the plume. Land above the FS-1 plume is primarily owned by the Town of Mashpee Conservation Commission or the Orenda Wildlife Land Trust and it is anticipated that the land use in the FS-1 area will not significantly change over time. The Quashnet bog area is fed primarily by groundwater discharge and serves as the headwaters for the Quashnet River, which originates in the bogs and flows south to Waquoit Bay. The Quashnet bogs were formerly cultivated as commercial cranberry bogs; however, the last cranberry crop was harvested at these bogs in 2006. In 2010, the Town of Mashpee officially decided to no longer cultivate cranberries from these bogs (AFCEE 2011a).

The topography of the land above the FS-1 plume can be characterized as a broad, flat, gently sloping glacial outwash plain that is pockmarked with glacial kettle holes such as the Quashnet Bog area or nearby Johns and Moody Ponds. Within the footprint of the plume, the maximum and minimum ground surface elevations are 105 ft msl and 30 ft msl, respectively.

5.8.2.3 Initial Responses

The summary of the initial responses is as follows:

Non-CERCLA Actions:

At the time of plume delineation and system startup in 1999, the Quashnet bogs were cultivated for a commercial cranberry crop. Detections of EDB in the Quashnet Bog surface water as a result of the plume discharge led to the cranberry farmers being compensated for lost crops by the DoD. In 2010, the property owner (Town of Mashpee) decided to no longer lease the bogs for cranberry cultivation and has allowed them to return to a natural state for natural resource habitat purposes.

CERCLA Actions:

Source Area Groundwater: The selected remedy for lead, thallium, and toluene in source area groundwater was LTM (AFCEE 2000).

EDB Groundwater Plume: In April 1999, a pilot study ETD remediation system was installed as an interim remedy in the area of groundwater upwelling at the Quashnet River bogs (AFCEE 1999a). The pilot study ETD system was designed to treat 750 gpm and consisted of the following components:

- Extraction of deep groundwater from one extraction well (36EW0005)
- Extraction of shallow groundwater from 175 shallow wellpoints (SWPs) along the Quashnet Bog boundary
- Treatment of extracted groundwater with GAC
- Reintroduction of treated water to the aquifer via an infiltration trench

- Discharge of treated water to surface water using vertical riser pipes (i.e., outflow bubblers)
- Construction and maintenance of earthen berms to isolate areas of potentially contaminated upwelling groundwater from other areas of the Quashnet bog system

The FS-1 ETD pilot system operated between 05 April 1999 and 13 October 2002 when a fire destroyed the treatment plant. A design concept for the selected remedy (axial and leading edge extraction) was presented in the final ROD (AFCEE 2000), with the final ETD system modified as described in the Final Wellfield Design Report (AFCEE 2001). The final ETD system (Figure 5-8A) was designed to treat 750 gpm and is comprised of:

- Four deep extraction wells (36EW0001, 36EW0005, 36EW0007, and 36EW0011)
- Treatment of extracted groundwater with GAC
- Discharge of treated water to surface water through three vertical riser pipes (bubblers)

The final ETD system began operation on 30 September 2003, at a design rate of 750 gpm. Further details regarding the FS-1 ETD system can be found in the O&M Plan (AFCEE 2012b).

An ESD for the IRP groundwater plumes was submitted in September 2011 that clarified the inclusion of MNA as a component of the selected remedy, slightly modified the phrasing of the RAOs, and updated the steps to achieve site closure (i.e., the three-step process) (AFCEE 2011b).

5.8.2.4 Basis for Taking Action

Future residential exposure to FS-1 groundwater COCs presents an excess lifetime cancer risk greater than the acceptable MassDEP threshold of $1x10^{-5}$ and the acceptable EPA range of $1x10^{-4}$ to $1x10^{-6}$. In addition, the MassDEP target risk of 1×10^{-5} was exceeded for current and future recreational waders (adult) exposed to surface water, sediment, and fish ingestion (AFCEE 1999b).

An ecological risk assessment concluded that adverse effects to ecological receptors, birds, mammals, amphibians, fish, or benthic invertebrates are not likely from exposure to soil, surface water, or sediments at FS-1 (AFCEE 1999b).

5.8.3 Remedial Actions

The final remedy for the FS-1 plume was determined in the *Final Record of Decision Area of Contamination FS-1* (AFCEE 2000) which was signed on 15 May 2000. The final design for the remedial system was presented and approved in the 2001 Final Wellfield Design Report (AFCEE 2001).

The RAOs for the FS-1 groundwater plume (AFCEE 2000) as modified by the global ESD (AFCEE 2011b) are as follows:

- Prevent residential exposure to FS-1 groundwater with EDB concentrations greater than the MMCL of 0.02 µg/L.
- Prevent residential exposure to FS-1 groundwater with lead concentrations greater than EPA Treatment Technique action level of 15 µg/L.
- Prevent residential exposure to FS-1 groundwater with thallium concentrations greater than the MCL of 2 µg/L.
- Prevent residential exposure to FS-1 groundwater with toluene concentrations greater than the MCL of 1,000 µg/L.
- Restore usable groundwaters to their beneficial uses wherever practicable, within a timeframe that is reasonable given the particular circumstances of the site.
- Prevent worker, recreational youth and adult wader contact with Quashnet River water containing unacceptable concentrations of EDB and ingestion of fish exposed to Quashnet River water containing unacceptable concentrations of EDB*.

  * Note that subsequent to the completion of the ROD, a screening-level human health risk evaluation was conducted to examine the potential for imminent human health risks from exposure to surface water containing EDB (Appendix D of AFCEE 2003). This screening level evaluation for EDB resulted in the development of an RBC for EDB of 6.5 µg/L in surface water at a target risk of 1×10^{-3} (constituting the potential for "imminent human health risks").

5.8.3.1 Remedy Selection and Implementation

The selected remedy for FS-1 groundwater in the ROD (AFCEE 2000) included the following components:

- continued operation of the pilot-test ETD system;
- installation of up to 17 additional deep extraction wells and 19 reinjection wells (final number to be based on additional plume characterization and optimization modeling to be completed subsequent to completion of the ROD);
- monitoring of source area groundwater for lead, thallium, and toluene;
- monitoring groundwater and surface water for EDB;
- restricting groundwater use within the areas contained by the treatment system through imposition of institutional controls (i.e., LUCs); and
- completion of CERCLA reviews every five years throughout the lifetime of the remedial action.

Modeling completed at the time of the ROD indicated that the MMCL of 0.02 μg/L for EDB would be achieved approximately seven years after the startup of the ETD system, at which time 83 percent of the plume was predicted to have been captured, 11 percent would discharge to the bogs, and six percent would remain in the aquifer (AFCEE 2000). However, this remedial timeframe was revised to 15 years after system startup (with regulatory agency approval) with the issuance of the Final Wellfield Design Report (AFCEE 2001) as described below.

Following the acceptance of the ROD and its associated conceptual design, an FS-1 pre-design data-gap investigation was completed in 2001 to obtain additional plume characterization data required to finalize the design of the final remedial system (AFCEE 2001). Findings obtained during this post-ROD data gap investigation resulted in refinements to the CSM for FS-1 including: (1) a definitive determination of the aquifer thickness and heterogeneity; (2) a refined understanding of the three-dimensional hydraulic conductivity field and groundwater flow characteristics; (3) detection of a previously uncharacterized area of elevated EDB mass in the southern third of the plume; (4) improved definition of the eastern plume boundary; and (5) the effect of convergent flow on the plume in the vicinity of the Quashnet River and bogs.

Therefore, the conceptual design specified in the ROD was modified based on analysis of field data and groundwater modeling conducted subsequent to issuance of the ROD and on input received from stakeholders (EPA, MassDEP, MDFW, Mashpee Conservation Commission). The final ETD system (Figure 5-8A) was designed to treat a combined extraction rate of 750 gpm and consisted of four deep extraction wells (36EW0001, 36EW0005, 36EW0007, and 36EW0011) that was predicted to remediate groundwater within a timeframe of 15 years after system startup. Extracted groundwater would be treated using GAC and treated water would be returned to surface water through three vertical riser pipes (bubblers) and the shallow aquifer through an infiltration gallery. EPA and MassDEP concurred with the final design on 10 May 2001 (AFCEE 2001).

Since the final ETD system came on line in 2003, the following changes to the remedy have occurred:

1) The institutional controls described in the ROD were further developed as described in the 2011 ESD for the IRP groundwater plumes (AFCEE 2011b). The ESD provides a more thorough description of the LUC program, including a private well verification program that is being instituted for all the MMR groundwater plumes.

2) The 2011 ESD also clarified the inclusion of MNA as a component of the selected remedy for FS-1 and added text regarding the MMR three-step process to achieve site closure.

Remedial system performance monitoring data and long-term plume monitoring data collected under the SPEIM/LTM program are used to assess: (i) whether the remedial objectives and system performance metrics are being met; (ii) whether remediation is progressing as expected; and (iii) to identify and assess optimization opportunities. The data collected under the SPEIM/LTM program are presented to the regulatory agencies through the Technical Update Meeting process and documented in annual SLRs.

As part of the LUC process specified in the ESD (AFCEE 2011b), a private well verification survey was completed at FS-1 between November 2012 and April 2013. The private well verification survey completed at the FS-1 LUC area consisted of outreach to

nine parcels. Outreach was achieved at 100 percent of the parcels within the FS-1 LUC area and no private wells were identified within the FS-1 LUC area. In the event that new private well information is obtained or plume monitoring data indicate a change to the CSM at FS-1, AFCEC will perform the necessary well determinations at the time the information becomes available (AFCEC 2013a)

5.8.3.2 Remedy Operation & Maintenance

The FS-1 remedial system is operated and maintained under an approved O&M Plan (AFCEE 2012b). The O&M Plan is updated on an annual basis and includes operational requirements, a summary of the operational history of the systems, and details of any system modifications, optimizations, or improvements. While occasional operational issues are identified, these issues have been, and continue to be, addressed in a timely and effective manner such that remedy O&M is considered effective at achieving the remedy goals. Operational issues are identified in O&M monthly reports and system performance and reliability is reported in the annual SLRs.

The annual SPEIM/LTM/O&M costs associated with ongoing remedial action at FS-1 are generally consistent with those predicted at the time of remedy selection (with consideration for savings associated with optimization initiatives) and do not indicate potential remedy problems.

5.8.4 Progress Since the Last Five Year Review

Per the EPA guidance document (EPA 2001), this section summarizes the progress made on the specific recommendations and follow-up actions presented in the prior third CERCLA Five Year Review (AFCEE 2008b). For the FS-1 groundwater plume, the recommendations and follow-up actions were:

1) Section 4.1 of the third Five Year Review recommended that a screening level VI evaluation be completed for each IRP groundwater site. The objective of the VI evaluation was to determine if a VI exposure pathway exists at a particular site,

and if so, complete a screening level evaluation to determine if VI risk above target levels is likely or unlikely.

2) Section 4.3 of the third Five Year Review recommended that, in order to ensure long term protectiveness, all groundwater sites with off-base plume areas must undergo the well verification process as described in AFCEC's guideline titled *Verification, Decommissioning, and Documentation Guidelines for Private Wells in Areas of Potential Concern* (AFCEE 2008c). It was recommended that this requirement be codified in an ESD for those off-base groundwater sites with RODs that do not currently contain the well verification language as part of the required LUCs. For off-base groundwater sites without final RODs at the time of the third Five Year Review (AV and CS-10), the well verification language should be included in the LUC requirements presented in the Final RODs.

3) The RAOs in the ROD required that the Air Force "prevent or reduce residential exposure". The third Five Year Review recommended that the RAOs be modified to eliminate the word "reduce" to better ensure long-term protectiveness.

Progress since the last Five Year Review against these recommendations and follow-up actions is as follows:

1) A VI evaluation was completed for the 16 IRP groundwater sites at the MMR as documented in the *Final 2011 MMR Vapor Intrusion Evaluation Technical Memorandum* (AFCEE 2012a) including FS-1. The VI evaluation indicated an incomplete pathway for VI at FS-1 and no further monitoring or data collection is needed specific to VI at FS-1. However, as part of the ongoing remedial actions at FS-1, AFCEC will continue to monitor the nature and extent of the FS-1 groundwater contamination under the SPEIM/LTM program and will re-evaluate the VI exposure pathway if conditions change such that VI could be a concern.

2) The *Final Explanation of Significant Differences for the Installation Restoration Program Groundwater Plumes at the Massachusetts Military Reservation* (AFCEE 2011b), was signed on 14 September 2011 and included the requirement

to complete the private well verification portion of the LUCs at FS-1 within three years of the signing of the ESD. This well verification effort was completed in April 2013 and concluded that there are no private wells located within the FS-1 LUC area (AFCEC 2013a). Therefore, there is no potential for exposure to the FS-1 plume through use of a private well. Further details of the well verification process and findings are included in Section 5.8.3.1.

3) The 2011 ESD for the IRP groundwater plumes (AFCEE 2011b) modified the phrasing of the RAOs to remove the word "reduce". The revised RAOs are presented in Section 5.8.3.

5.8.5 Five Year Review Process

5.8.5.1 Data Review

The MMR SPEIM program was developed to monitor plume changes and to ensure the effective operation of the AFCEC groundwater remediation systems at the MMR. These objectives are met through monitoring of selected media (i.e., groundwater, surface water) within and outside the plume boundaries, treatment plant monitoring, and groundwater flow and transport modeling. The data collected under the SPEIM program are continually assessed by a team of on-site professional staff and the results of these assessments are presented to the regulatory agencies initially during Technical Update meetings and then through technical memoranda or project note deliverables, if warranted, based on the results of the data evaluation or to address particular plume issues.

In addition, AFCEC prepares annual SLRs for the groundwater plumes that are being addressed through active treatment. The purpose of these SLRs is to document the results of sampling activities conducted at each plume under the SPEIM program. The SLRs also include: (i) a summary of all major events and optimizations completed at the plume; (ii) O&M-related system performance information such as contaminant mass removal/air emissions, system flow rate summaries, and downtime summaries; and (iii) all relevant technical assessment documentation completed during the annual

reporting period as attachments or by reference. The SLRs are provided to the broad stakeholder group for each plume including Federal (EPA) and State (MassDEP, MassDPH) regulatory agencies, town departments (such as the BOHs, Departments of Public Work, Water Departments, and/or Conservation Commissions), affected property owners, and other interested parties. The SLRs are publically available in the IRP Administrative Record and copies are maintained at the local town libraries.

In addition to the annual SLRs prepared for FS-1 during this Five Year Review period (AFCEC 2013b, AFCEE 2012c, 2011d, 2010b, 2009b, 2008e), the following technical deliverables were prepared that assessed system performance or presented the results of optimization evaluations:

- *FS-1 2007 Semiannual SPEIM Data Presentation Project Note* (AFCEE 2008d)
- *FS-1 2008 Annual SPEIM Data Presentation and Plume Boundary Update Project Note* (AFCEE 2008a)
- *FS-1 2008 Semiannual SPEIM Data Presentation Project Note* (AFCEE 2009a).
- *FS-1 2009 Triennial SPEIM Data Presentation and ETD System Optimization Approach Project Note.* (AFCEE 2010a).
- *FS-1 2010 Annual SPEIM Data Presentation and ETD System Optimization Project Note.* (AFCEE 2011c).
- *FS-1 2011 Annual SPEIM Data Presentation, ETD System Optimization Update and Source Are Groundwater Monitoring Update.* (AFCEE 2012d).
- *FS-1 2012 Triennial SPEIM Data Presentation, Network Optimization, and Supplemental Monitoring Results Project Note.* (AFCEC 2012).

The primary findings and conclusions from these system performance evaluations at FS-1 are as follows:

1. The final FS-1 ETD system removed approximately 0.824 lbs of EDB through treatment of approximately 1.3 billion gallons of groundwater during this Five Year Review period. In total, the FS-1 ETD systems (pilot-test and final) have treated approximately 4 billion gallons of contaminated groundwater and

removed approximately 17.93 lbs of EDB since system startup in April 1999 through December 2012.

2. A comparison of the FS-1 plume boundary at the start and end of this Five Year Review period (i.e., 2007 versus 2012) is included on **Figure 5-8B**. EDB concentration trends at select monitoring wells are provided in **Figure 5-8C**. The highest EDB detection in the FS-1 plume between 2007 and 2012 was 3.02 µg/L collected from monitoring well 36MW1041A in 2007. The five highest EDB detections at FS-1 in 2007 ranged from 0.026 to 3.02 µg/L. In 2012, the five highest EDB detections ranged from below the reporting limit to 0.102 µg/L.

3. Through a combination of active treatment and natural attenuation, the EDB plume remediation is progressing as expected. A review of the SPEIM data indicate that the plume extent and concentrations are declining slightly faster than expected when compared to the modeling predictions presented in the Final FS-1 Wellfield Design Report (AFCEE 2001). Therefore, the restoration timeframe predicted by groundwater modeling in support of the final remedial design (i.e., approximately 2018) should be met or exceeded. LTM data indicate the remedial goals for toluene (the MCL of 1,000 µg/L) and thallium (the MCL of 2 µg/L) in source area groundwater have been reached and monitoring for these two COCs has been discontinued; however, lead remains in groundwater at concentrations that are at or slightly below the standard of 15 µg/L (which is an action level for lead in tap water in distribution systems). Monitoring for lead in groundwater continues through regularly scheduled sampling of the source area monitoring wells.

4. Since the last Five Year Review, the surface water monitoring network at FS-1 has been reduced from eight locations that were sampled several times throughout the year to one location sampled on an annual basis (AFCEE 2011a). The decision to reduce surface water monitoring was primarily due to the lack of EDB detections. In addition, many of the surface water locations

were previously sampled to provide water quality data to support decisions regarding the marketability of cranberries grown in the bogs. In 2010, the property owner (Mashpee Conservation Commission) decided to no longer cultivate these bogs. Therefore, surface water data to support cranberry marketability decisions were no longer needed (AFCEE 2011a). No EDB was detected in 2012 at the one surface water location that continues to be monitored.

5. Plume monitoring under AFCEC's SPEIM/LTM program should continue at FS-1 to provide the necessary data to manage potential exposure risks, assess remedial progress, and evaluate optimization opportunities.

5.8.5.2 Site Inspections

Refer to Section 3.5.

5.8.5.3 Interviews

Refer to Section 3.6.

5.8.6 Technical Assessment

The technical assessment component of the Five Year Review consists of evaluating the protectiveness of the remedy. The technical assessment is based on EPA guidance provided in Section 4.0 of the Comprehensive Five Year Review Guidance (EPA 2001).

5.8.6.1 Question A: Is the remedy functioning as intended by the decision documents?

Yes, startup of the pilot ETD system in 1999, completion of the ROD in 2000, startup of the final ETD system in 2003, continued operation of the remedial system, and completion of the well verification/well determination portion of the LUCs in early 2013 have resulted in the remedy functioning as intended by the decision documents. The remedial system is performing as expected. Through the combination of the active treatment by the remedial system and natural attenuation processes groundwater cleanup

levels are expected to be achieved within the timeframe approximated in the Wellfield Design Report (AFCEE 2001), which modified the remedial timeframes originally presented in the ROD (see Section 5.8.3.1). Operational costs are appropriate for the remedy and a robust optimization program continues to reduce future costs. Monitoring and evaluation activities are continual and well-documented.

5.8.6.2 Question B: Are the exposure assumptions, toxicity data, cleanup levels, and remedial action objectives (RAOs) used at the time of the remedy selection still valid?

Changes in Standards and To-Be Considered: There have been no changes in standards or TBC guidance.

Changes in Exposure Pathways: There have been no changes to exposure pathways or land use of the site that would affect the protectiveness of the remedy. It is noted that the Quashnet Bogs are no longer cultivated for cranberries, eliminating potential for exposure of cranberry workers to EDB in surface water. However, surface water in the Quashnet River may continue to be used for recreational purposes including fishing and it is anticipated that such uses of surface water will continue. Additionally, since the VI exposure pathway was not considered in the RI, a more thorough evaluation has been completed and the VI pathway was found to be incomplete (AFCEE 2012a).

Changes in Toxicity and Other Contaminant Characteristics. There have been no changes in the toxicity factors or other contaminant characteristics for the FS-1 groundwater COCs EDB, toluene, and lead since the last Five Year Review (i.e., 2007) and the cleanup levels remain 0.02 µg/L, 1,000 µg/L, and 15 µg/L, respectively. However, the toxicity values for thallium have been updated since 2007.

An oral non-cancer toxicity value for thallium was published by EPA in October 2012 (EPA 2012). The updated oral non-cancer toxicity value is seven times more conservative than what was previously published by EPA Region 3 (EPA 2008). These toxicity changes for thallium did not lead to a change in the MCL of 2 µg/L. It is noted that thallium has not been detected in source area groundwater since 2002.

Since the RAOs and risk management decisions associated with FS-1 groundwater are based on MCL/MMCLs, this change in toxicity for thallium does not affect the protectiveness of the remedy. However, the updated toxicity values (or values derived from future updates) for the FS-1 COCs should be used when performing the residual risk assessment as part of the three-step process to achieve site closure (AFCEE 2011b).

The RBC for human health exposure to EDB in FS-1 surface water of 6.5 µg/L for a target risk of 1 x 10^{-3} (i.e., imminent human health risk) that was developed in 2003 (AFCEE 2003) has been recalculated using updated toxicity information. In 2004, the carcinogenic toxicity value for EDB for oral exposure was revised downward by more than an order of magnitude (EPA 2012). Therefore, the 2003 surface water RBC of 6.5 µg/L does not reflect the most recent EPA toxicity values for EDB. The RBC for EDB in surface water was recalculated for exposure to surface water containing EDB associated with the FS-28 groundwater plume (Coonamessett River) using exposure assumptions similar to those used for FS-1 in 2003. The recalculated RBC for EDB in surface water at FS-28 increased from 7.71 µg/L to 328 µg/L (under the "imminent risk to human health" scenario). A similar increase would be expected, and relevant, for exposure to EDB in surface water at FS-1 (Quashnet River).

It is noted that a maximum EDB concentration of 1.69 µg/L was detected in a surface water sample collected at the Quashnet bog in 1998, prior to startup of the remedial system and the magnitude, frequency, and aerial extent of EDB detections in surface water have decreased significantly since that time. No EDB was detected in FS-1 surface water when sampled in 2012 (AFCEC 2013b).

<u>Changes in Risk Assessment Methods</u>: There were no changes in risk assessment methodology.

<u>Review of RAOs</u>: The RAOs developed for the final ROD (AFCEE 2000) and revised in the 2011 ESD (AFCEE 2011b) are appropriate and remain valid.

5.8.6.3 Question C: Has any other information come to light that could call into question the protectiveness of the remedy?

No.

5.8.7 Issues, Recommendations, and Follow-Up Actions

No specific recommendation or follow-up actions have been identified. However, the topic of emerging contaminants should be monitored as it relates to groundwater at FS-1 and the MMR.

5.8.8 Protectiveness Statement

The remedy for the FS-1 groundwater plume is protective of human health and the environment. The remedial system is performing as expected. The LUCs are in place and are functioning as intended. Through the combination of the active treatment by the remedial system and natural attenuation processes, groundwater cleanup levels are expected to be achieved within the timeframe approximated in the ROD, and revised in the Wellfield Design Report, which was considered reasonable given the particular circumstances of the site.

5.8.9 References

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5.9 FUEL SPILL-12 (FS-12) GROUNDWATER

The FS-12 plume is a dissolved-phase groundwater plume (**Figure 5-9A**) that is defined as the extent of groundwater containing the primary FS-12 COC, EDB, at concentrations exceeding the MMCL of 0.02 μg/L. Benzene is also a COC for the FS-12 plume, however, benzene has not been detected at concentrations above the MCL of 5 μg/L within the plume monitoring network since 2006 or within the source area monitoring network since 2007.

5.9.1 Site Chronology

1990: Contaminants associated with the FS-12 plume were first detected in groundwater when the Sandwich Water District performed exploratory drilling for future municipal water supply wells (AFCEE 2006).

1992-1995: An SI and RI were completed (ANG 1992, 1995b).

1995: The NGB, DOD, EPA, MassDEP, and local communities approved a Plume Response Plan that presented an accelerated effort toward "simultaneous containment" of seven IRP groundwater plumes, including FS-12. An IROD for the seven groundwater plumes emanating from the MMR was signed on 25 September 1995 (ANG 1995a). The IROD stated that groundwater extraction and treatment systems should be designed, installed, and operated until a final remedy for the site is chosen. For FS-12, the interim remedy consisted of an ETR system to capture the plume.

1996-1997: Installation and startup of an interim ETR system consisting of 25 extraction wells and 23 reinjection wells under the IROD (ANG 1995a).

2005: A feasibility study and proposed plan were submitted (AFCEE 2005a, 2005b).

2006: ROD finalized (AFCEE 2006).

<u>2011</u>: An ESD was prepared that clarified the inclusion of MNA as a component of the selected remedy, revised the LUCs, slightly modified the phrasing of the RAOs, and added text regarding the MMR three-step process to achieve site closure (AFCEE 2011b).

5.9.2 Background

5.9.2.1 <u>History of Contamination</u>

The FS-12 groundwater plume originated from a break in an underground pipeline located along Greenway Road that was originally believed to be discovered in 1972 (**Figure 5-9A**). However records have shown that the leak was discovered in 1970. The operation of the pipeline was discontinued in 1973. In January 1992, the FS-12 RI was initiated. As a result of modeling conducted for the RI, the FS-12 release was estimated to be about 70,000 gallons of AVGAS and JP-4 (AFCEE 2006). At the time of the RI, dissolved phase groundwater contamination (BTEX and EDB) extended from the source area to approximately 5,000 ft downgradient (i.e., south-southwest).

5.9.2.2 <u>Physical Characteristics, Land and Resource Use</u>

Based on the most recent groundwater monitoring data collected in 2012, the main body of the FS-12 plume is approximately 1,900 ft long, up to 1,250 ft wide, and is approximately 45 ft thick. The plan view extent of the FS-12 plume is shown on **Figure 5-9A**. The footprint of the FS-12 plume was approximately 36 acres in 2007 and was approximately 25 acres in 2012 (**Figure 5-9B**).

Land above the FS-12 groundwater plume consists of undeveloped areas and a summer camp. It is anticipated that the land use over the FS-12 plume area will not significantly change over time. Snake Pond, a kettle pond that is fed by groundwater, is used for recreational purposes such as fishing, swimming, and boating. In addition, a public beach is located on the southeast side of Snake Pond. Within the footprint of the plume, the maximum and minimum ground surface elevations are 140 ft msl and 70 ft msl, respectively.

5.9.2.3 Initial Responses

A summary of the initial responses is as follows:

Non-CERCLA Actions:

Private residences and the nearby summer camp that are located in the vicinity of the FS-12 plume were connected to the municipal water supply.

CERCLA Actions:

The TRET, established in 1996 as part of a new IROD management process, reviewed wellfield designs and determined that the 60-percent design for containment of several of the IROD plumes would cause negative ecological impacts (TRET 1996). The proposed interim remedy for the FS-12 groundwater plume consisted of treatment using an ETR system with the goal of restoring the aquifer and preventing further downgradient migration of the plume. The approach for plume containment at FS-12 was revised, in part, as follows (AFCEE 2006):

- The treatment system would consist of 25 extraction wells[1].
- The extraction wells would be arranged across the toe of the southern extent of the FS-12 plume and in an axial arrangement intercepting the central portion of the plume with the highest contaminant concentrations.
- Treated water would be returned through 23 reinjection wells[2]. These reinjection wells would be placed downgradient of the extraction toe fence and west of the axial wells near the eastern shore of Snake Pond.

1 Extraction wells 90EW0004 and 90EW0005 were not installed because it was determined that, after installation of 90EW0001 through 90EW0003, these wells were not needed based on subsequent characterization of the FS-12 plume.

2 Reinjection wells 90RIW0001, 90RIW0002, 90RIW0003, and 90RIW0004 were designed to be placed north of Snake Pond, but it was determined that these wells were not needed based on a subsequent characterization of the nature and extent of the FS-12 plume. Reinjection wells 90RIW0011 and 90RIW0012 were not installed at the landowner’s request. Reinjection well 90RIW0019 was not installed because its position on the toe fence was believed to interfere with the nearby J. Braden Thompson groundwater plume, which is not associated with the MMR. RIW0010 was converted to extraction well 90EW0031 in 2000 (AFCEE 2006).

The revised design was implemented and the FS-12 ETR system began operation on 18 September 1997 at a design flow rate of 772 gpm (**Figure 5-9A**). This ETR system became the selected remedy in the final ROD (AFCEE 2006). Further details regarding the FS-12 remedial system can be found in the 2012 O&M Plan (AFCEE 2012b).

An ESD for the IRP groundwater plumes was submitted in September 2011 that clarified the inclusion of MNA as a component of the selected remedy at FS-12, further described the institutional controls, slightly modified the phrasing of the RAOs, and updated the steps to achieve site closure (i.e., the three-step process) (AFCEE 2011b).

5.9.2.4 Basis for Taking Action

Future residential exposure to the FS-12 groundwater COC (EDB and benzene) presents an excess lifetime cancer risk greater than the acceptable EPA range of $1x10^{-4}$ to $1x10-^{6}$(AFCEE 2006).

An ecological baseline risk assessment was not conducted for FS-12 because of the lack of evidence of plume discharge to Snake Pond. Extensive sampling over 10 years has not detected any FS-12 contaminants in Snake Pond surface water. Therefore, it is not expected that contamination associated with the FS-12 groundwater plume would pose unacceptable ecological risk (AFCEE 2006).

5.9.3 Remedial Actions

The final remedy for the FS-12 plume was determined in the *Final Record of Decision for Fuel Spill-12 Groundwater* (AFCEE 2006) which was signed on 28 September 2006.

- The RAOs for the FS-12 groundwater plume as presented in the ROD (AFCEE 2006) and modified in the ESD (AFCEE 2011b) are as follows:
  - Prevent residential exposure to FS-12 groundwater with benzene concentrations greater than the MCL of 5 µg/L.
  - Prevent residential exposure to FS-12 groundwater with EDB concentrations greater than the MMCL of 0.02 µg/L.

- Restore useable groundwaters to their beneficial uses wherever practicable, within a timeframe that is reasonable given the particular circumstances of the site.

5.9.3.1 Remedy Selection and Implementation

The selected remedy in the ROD (AFCEE 2006) included the following components:

- Continued operation of the FS-12 ETR system.
- The selected remedy includes the possibility of modifying the treatment system to improve system operation and to accelerate the cleanup timeframe.
- Implementation of LUCs with the performance objectives of:
  - Preventing access to, or use of, contaminated groundwater from the FS-12 plume (both on-base and off-base) until the groundwater no longer poses an unacceptable risk, and
  - Maintaining the integrity of the current or future remedial or monitoring system such as the treatment systems and monitoring wells.
- Chemical and hydraulic monitoring of the plume, as long as active remediation continues, and chemical monitoring of the plume until the RAOs are met.
- Completion of CERCLA reviews every five years throughout the lifetime of the remedial action.

Since the final remedy was selected in 2006, the 2011 ESD for the IRP groundwater plumes (AFCEE 2011b) clarified the inclusion of MNA as a component of the selected remedy for FS-12, further described the LUC requirements, modified the phrasing of the RAOs, and added text regarding the MMR three-step process to achieve site closure.

Remedial system performance monitoring data and long-term plume monitoring data collected under the SPEIM program are used to assess: (i) whether the remedial objectives and system performance metrics are being met; (ii) whether remediation is progressing as expected; and (iii) to identify and assess optimization opportunities. The data collected under the SPEIM program are presented to the regulatory agencies through the Technical Update meeting process and documented in annual Summary Letter Reports.

As part of the LUC process specified in the ESD (AFCEE 2011b), a private well verification survey was completed at FS-12 between May 2011 and April 2013 (AFCEC 2013a). The private well verification survey completed at the FS-12 LUC area consisted of outreach to 14 parcels. Responses were obtained from 100 percent of the property owners within the FS-12 LUC area and no active private wells were identified. One property (summer camp) indicated to AFCEC that they formerly used one or more wells for irrigation and potable water supplies prior to being connected to municipal water by AFCEE in 1993. However, the current operator of the camp verified that none of these former wells are in use (and in fact does not know the location of all the wells).

The status of these non-operational private wells at the summer camp will continue to be tracked. AFCEC will distribute a mailing, on an annual basis, to the property owner. The intent of the annual mailing is to remind the camp property owner that they should contact AFCEC for a technical evaluation, which may include sampling, in the event any of their wells are put back into service. In addition to these annual mailings, AFCEC will perform outreach as part of future Five Year Reviews to the camp property owner requiring confirmation of the non-operational status of their wells (AFCEC 2013a).

5.9.3.2 Remedy Operation & Maintenance

The FS-12 remedial system is operated and maintained under an approved O&M Plan (AFCEE 2012b). The O&M Plan is updated on an annual basis and includes operational requirements, a summary of the operational history of the systems, and details of any system modifications, optimizations, or improvements. While occasional operational issues are identified, these issues have been, and will continue to be, addressed in a timely and effective manner such that O&M associated with the remedy is considered effective at achieving the remedy goals. Operational issues are identified in O&M monthly reports and system performance and reliability is reported in the annual SLRs.

The annual SPEIM/LTM/O&M costs associated with ongoing remedial action at FS-12 are generally consistent with those predicted at the time of remedy selection (with consideration for savings associated with optimization initiatives) and do not indicate potential remedy problems.

5.9.4 Progress Since the Last Five Year Review

Per the EPA guidance document (EPA 2001), this section summarizes the progress made on the specific recommendations and follow-up actions presented in the prior third CERCLA Five Year Review (AFCEE 2008b). For the FS-12 groundwater plume, the recommendations and follow-up actions were:

1) Section 4.1 of the third Five Year Review recommended that a screening level VI evaluation be completed for each IRP groundwater site. The objective of the VI evaluation was to determine if a VI exposure pathway exists at a particular site, and if so, complete a screening level evaluation to determine if VI risk above target levels is likely or unlikely.

2) Section 4.3 of the third Five Year Review recommended that, in order to ensure long term protectiveness, all groundwater sites with off-base plume areas must undergo the well verification process as described in AFCEC's guideline titled *Verification, Decommissioning, and Documentation Guidelines for Private Wells in Areas of Potential Concern* (AFCEE 2008d). It was recommended that this requirement be codified in an ESD for those off-base groundwater sites with RODs that do not currently contain the well verification language as part of the required LUCs. For off-base groundwater sites without final RODs at the time of the third Five Year Review (AV and CS-10), the well verification language should be included in the LUC requirements presented in the Final RODs.

3) The RAOs in the ROD required that the Air Force "prevent or reduce residential exposure". The third Five Year Review recommended that the RAOs be modified to eliminate the word "reduce" to better ensure long-term protectiveness.

Progress since the last Five Year Review against these recommendations and follow-up actions is as follows:

1) A VI evaluation was completed for the 16 IRP groundwater sites at the MMR as documented in the *Final 2011 MMR Vapor Intrusion Evaluation Technical Memorandum* (AFCEE 2012a) including FS-12. The VI evaluation indicated an incomplete or insignificant pathway for VI at FS-12 and no further monitoring or data collection is needed specific to VI at FS-12. However, as part of the ongoing remedial actions at FS-12, AFCEC will continue to monitor the nature and extent of the FS-12 groundwater contamination under the SPEIM/LTM program and will re-evaluate the VI exposure pathway if conditions change such that VI could be a concern.

2) The *Final Explanation of Significant Differences for the Installation Restoration Program Groundwater Plumes at the Massachusetts Military Reservation* (AFCEE 2011b) was signed on 14 September 2011 and included the requirement to complete the private well verification portion of the LUCs at FS-12 within three years of the signing of the ESD. This well verification effort was completed in April 2013 and concluded that there are no private wells located within the FS-12 LUC area (AFCEC 2013a). Therefore, there is no potential for exposure to the FS-12 plume through use of a private well. Further details of the well verification process and findings are included in Section 5.9.3.1.

3) The 2011 ESD for the IRP groundwater plumes (AFCEE 2011b) modified the phrasing of the RAOs to remove the word “reduce”. The revised RAOs are presented in Section 5.9.3.

5.9.5 Five Year Review Process

5.9.5.1 Data Review

The MMR SPEIM program was developed to monitor plume changes and to ensure the effective operation of the AFCEC groundwater remediation systems at the MMR. These objectives are met through monitoring of selected media (i.e., groundwater, surface

water) within and outside the plume boundaries, treatment plant monitoring, and groundwater flow and transport modeling. The data collected under the SPEIM program are continually assessed by a team of on-site professional staff and the results of these assessments are presented to the regulatory agencies initially during Technical Update meetings and then through technical memoranda or project note deliverables, if warranted, based on the results of the data evaluation or to address particular plume issues.

In addition, AFCEC prepares annual SLRs for the groundwater plumes that are being addressed through active treatment. The purpose of these SLRs is to document the results of sampling activities conducted at each plume under the SPEIM program. The SLRs also include: (i) a summary of all major events and optimizations completed at the plume; (ii) O&M-related system performance information such as contaminant mass removal/air emissions, system flow rate summaries, and downtime summaries; and (iii) all relevant technical assessment documentation completed during the annual reporting period as attachments or by reference. The SLRs are provided to the broad stakeholder group for each plume including Federal (EPA) and State (MassDEP, MassDPH) regulatory agencies, town departments (such as the BOHs, Departments of Public Work, Water Departments, and/or Conservation Commissions), affected property owners, and other interested parties. The SLRs are publically available in the IRP Administrative Record and copies are maintained at the local town libraries.

In addition to the annual SLRs prepared for FS-12 during this Five Year Review period (AFCEC 2013b, AFCEE 2012c, 2011e, 2010b, 2009b, 2008f), the following technical deliverables were prepared that assessed system performance or presented the results of optimization evaluations:

- *Fuel Spill-12 2012 Annual SPEIM Data Presentation Project Note* (AFCEC 2013c)
- *Fuel Spill-12 2011 EDB Plume Shell Update Project Note* (AFCEE 2011a)
- *Fuel Spill-12 2011 SPEIM Chemical Network Optimization Project Note* (AFCEE 2011c)

- *Fuel Spill- 12 2011 Annual SPEIM Data Presentation Project Note* (AFCEE 2011d)
- *Fuel Spill-12 2010 Annual SPEIM Data Presentation Project Note* (AFCEE 2011f)
- *Fuel Spill-12 2010 Extraction, Treatment and Reinjection System Optimization Project Note* (AFCEE 2010a)
- *Fuel Spill-12 2008 Semiannual SPEIM Data Presentation and Hydraulic Capture Zone Analysis Project Note* (AFCEE 2009a)
- *Fuel Spill-12 2008 Annual SPEIM Data Presentation and Chemical Network Optimization Project Note* (AFCEE 2008a)
- *Fuel Spill-12 2008 Extraction, Treatment and Reinjection System Optimization Project Note* (AFCEE 2008c)
- *Fuel Spill-12 2007 Semiannual SPEIM Data Presentation Project Note* (AFCEE 2008e)

While additional details are provided in the documents listed above, the primary findings and conclusions from these system performance evaluations at FS-12 are as follows:

1. The FS-12 remedial system removed approximately 3.0 lbs of COCs through the treatment of approximately 944 million gallons of groundwater during this Five Year Review period. In total, the FS-12 ETR system has treated approximately 4.6 billion gallons of contaminated groundwater and removed approximately 193 lbs of COCs since system startup in September 1997 through December 2012.

2. A comparison of the FS-12 plume boundary at the start and end of this Five Year Review period (i.e., 2007 versus 2012) is included on **Figure 5-9B**. EDB concentration trends at select groundwater monitoring wells are shown in **Figure 5-9C**. The highest EDB detection in the FS-12 plume between 2007 and 2012 was 52.2 µg/L collected from monitoring well 90MW0106B in 2008. The five highest EDB detections at FS-12 in 2007 ranged from 3.15 to 35.8 µg/L. In 2012, the five highest EDB detections at FS-12 ranged from 0.636 to 27.3 µg/L.

3. The FS-12 remedial system is achieving plume containment and is removing EDB contaminant mass (benzene is no longer detected in the FS-12 groundwater monitoring network). EDB has not been detected downgradient of the remedial system and the plume footprint has reduced since system startup in 1997.

4. Contaminant transport modeling completed since completion of the ROD and SPEIM data collected through 2012 indicate that the aquifer restoration timeframe may be longer than that predicted by modeling completed in support of the ROD (AFCEE 2006). Modeling completed in support of the ROD predicted that aquifer restoration would be achieved by approximately 2030. Groundwater modeling completed in support of a 2005 ETR system optimization (AFCEE 2005c) indicated that EDB would remain at depth in the aquifer beyond the last simulation year of 2048. The difference between the predicted aquifer restoration timeframe presented in the ROD versus that completed as part of the 2005 optimization evaluation is primarily due to the presence of EDB contamination (characterized after the completion of the ROD modeling) that is located deep in the aquifer in the core of the plume (AFCEE 2005c). Groundwater transport modeling and field data collected at FS-12 indicate that the design goals for the existing ETR system (i.e., plume containment and mass removal) continue to be met. However, there was some uncertainty in the 2005 optimization transport modeling predictions regarding the extent of EDB contamination in silts of low hydraulic conductivity that are located deeper in the aquifer and how the fate of this contamination is simulated by the model. AFCEC plans to assess this issue as part of an upcoming optimization evaluation. A goal of the evaluation will be to better understand this aspect of the CSM and therefore reduce the uncertainty in the model-predicted restoration timeframe.

5. SPEIM data indicate the remedial goal for benzene (the MCL of 5 μg/L) in groundwater has been reached, since benzene has not been detected at concentrations above the MCL since 2007. Therefore, monitoring for this COC was discontinued in 2011 (AFCEE 2011c).

6. Plume monitoring under AFCEC's SPEIM/LTM program should continue at FS-12 to provide the necessary data to manage potential exposure risks, assess remedial progress, and evaluate optimization opportunities.

5.9.5.2 Site Inspections

Refer to Section 3.5.

5.9.5.3 Interviews

Refer to Section 3.6.

5.9.6 Technical Assessment

The technical assessment component of the Five Year Review consists of evaluating the protectiveness of the remedy. The technical assessment is based on EPA guidance provided in Section 4.0 of the Comprehensive Five Year Review Guidance (EPA 2001).

5.9.6.1 Question A: Is the remedy functioning as intended by the decision documents?

Yes, continued operation of the ETR system installed as the interim remedy in 1997, completion of the ROD in 2006, and completion of the well verification/well determination portion of the LUCs in early 2013 have resulted in the remedy functioning as intended by the decision documents. However, a review of SPEIM data and modeling predictions generated since the ROD indicate that the ETR system may not meet the aquifer restoration timeframes presented in the ROD (i.e., by 2030). The primary reason for this difference is due to a change in the CSM where previously uncharacterized EDB contamination has been detected in the core of the plume at higher concentrations and deeper in the aquifer than previously depicted in the model simulations available at the

time of remedy selection and presented in the ROD (AFCEE 2005c). A modeling-based remedial system optimization assessment is planned for 2013 which will update the estimated restoration timeframe at FS-12. The updated restoration timeframe approximation will be compared to the information presented in the ROD and will be used to determine whether the RAO related to aquifer restoration (see Section 5.9.3) is being achieved.

Plume and remedial system monitoring is being conducted under the SPEIM/LTM and LUC programs and risk management measures are in place. Operational costs are appropriate for the remedy and a robust optimization program continues with the objective of reducing remedial system operational timeframes, the time to reach remedial goals (e.g., MMCLs), and reducing future costs. Monitoring and evaluation activities are continual and well-documented.

5.9.6.2 Question B: Are the exposure assumptions, toxicity data, cleanup levels, and remedial action objectives (RAOs) used at the time of the remedy selection still valid?

Changes in Standards and To-Be Considered: There have been no changes in standards or TBC guidance.

Changes in Exposure Pathways: There have been no changes to exposure pathways or land use of the site that would affect the protectiveness of the remedy. It is noted that a more thorough evaluation of the VI pathway was completed at FS-12 since the completion of the ROD and the VI pathway was found to be incomplete or insignificant (AFCEE 2012a).

Changes in Toxicity and Other Contaminant Characteristics: There have been no changes in the toxicity factors or other contaminant characteristics for the FS-12 groundwater COCs, EDB and benzene. The EDB MMCL remains at 0.02 µg/L and the MCL for benzene remains at 5 µg/L.

Changes in Risk Assessment Methods: There were no changes in risk assessment methodology.

Review of RAOs: The RAOs developed for the final ROD (AFCEE 2006) and revised in the 2011 ESD (AFCEE 2011b) are appropriate and remain valid.

5.9.6.3 Question C: Has any other information come to light that could call into question the protectiveness of the remedy?

No.

5.9.7 Issues, Recommendations, and Follow-Up Actions

Contaminant transport modeling completed since the ROD indicate that the restoration timeframe predicted at the time of remedy selection (i.e., by 2030) may not be met. The longer model-predicted restoration timeframe is primarily due to a change in the CSM related to the nature and extent of EDB contamination in the core of the plume.

An optimization assessment of the FS-12 remedial system should be performed with an updated plume shell that more closely represents the current distribution of contamination based on the updated CSM. The optimization evaluation should assess the performance of the remedial system, determine whether improvements can be made, and update the restoration timeframe prediction for comparison to the information presented in the ROD. If necessary at the conclusion of the optimization assessment, an ESD presenting the updated CSM and/or the updated prediction for aquifer restoration timeframe should be completed for FS-12.

In addition, the topic of emerging contaminants should be monitored as it relates to groundwater at FS-12 and the MMR.

5.9.8 Protectiveness Statement

The remedy for the FS-12 groundwater plume is protective of human health and the environment. The remedial system is performing as expected and the LUCs are in place and are functioning as intended. Through the combination of the active treatment by the remedial systems and natural attenuation processes, groundwater cleanup levels are expected to be achieved. However, due to a change in the CSM, the aquifer restoration

timeframe may be longer than expected at the time of remedy selection and this will be further assessed. When an updated estimate of the aquifer restoration timeframe is available, it will be determined whether the RAO of restoring the aquifer in a reasonable timeframe is being met. Since the LUCs are in place and are functioning as intended to prevent exposure and there are no current plans to use the portion of the aquifer where FS-12 contamination remains for water supply, the remedy remains protective.

5.9.9 References

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5.10 FUEL SPILL-13 (FS-13) GROUNDWATER

The FS-13 groundwater plume was a dilute dissolved-phase groundwater plume located within the MMR. The groundwater contamination at FS-13 has not been delineated as a contiguous plume since 2004 due to its limited extent. For reference, the 2004 FS-13 plume boundary is shown on **Figure 5-10**. The FS-13 plume area is located within the footprint of the CS-10 plume, although it is shallower in the aquifer than CS-10, with contamination located near the water table. The groundwater COCs for FS-13 are 1,2,4-TMB and 1,3,5-TMB, or TMBs collectively (AFCEE 2000). There are no applicable drinking water standards for 1,2,4-TMB and 1,3,5-TMB. However, the calculated HEC, based on a HI equal to 1, for each COC is 17 µg/L (AFCEE 2000).

5.10.1 Site Chronology

1972: Discovery of a leaking underground fuel supply pipeline carrying JP-4 near the rotary at the east end of Connery Avenue during a routine walkover inspection. Subsequently, the area was investigated and excavated and a section of pipe was replaced (Aneptek 1996).

1995-1999: A SI at FS-13 was conducted (1995), followed by an RI field program (1996) consisting of drilling and groundwater sampling (Stone & Webster 1997). RI activities were completed in 1998 and documented in the SWOU RI Report (AFCEE 1999c).

1999: The feasibility study was completed in June 1999 (AFCEE 1999b) and the proposed plan was released to the public in June 1999 (AFCEE 1999a).

2000: A ROD was completed that identified the remedy for the FS-13 plume as Limited Action, consisting of LTM and institutional controls (AFCEE 2000).

2008: An ESD was submitted to further describe the institutional controls associated with the remedy (AFCEE 2008b).

2011: An ESD was prepared that clarified the inclusion of MNA as a component of the selected remedy, slightly modified the phrasing of the RAOs, and added text regarding the MMR three-step process to achieve site closure (AFCEE 2011).

5.10.2 Background

5.10.2.1 History of Contamination

The source of the FS-13 plume was a release of an estimated 2,000 gallons of JP-4 that is believed to have occurred near the rotary at the east end of Connery Avenue. The fuel spill was discovered in 1972 during a routine walkover inspection of an underground fuel supply pipeline. Subsequently, the area was investigated and excavated and a section of pipe was replaced. A Site Inspection Technical Memorandum (SITM) was completed in 1996 (Aneptek 1996) and a Supplemental Site Inspection (SSI) was completed in 2006 for the FS-13 source area (AFCEE 2006b). No further action was recommended for the FS-13 source area based on the evaluation of sampling data collected from the site characterization efforts of the 1996 SITM and 2006 SSI. A decision document was prepared to document the no further action decision for the FS-13 source area (AFCEE 2006a). In October 2007, the FS-13 source area was delisted as part of the partial deletion of sites from the Otis Air National Guard Base/Camp Edwards Superfund Site.

5.10.2.2 Physical Characteristics, Land and Resource Use

When last able to be delineated in 2004, the FS-13 plume was approximately 610 ft in length, approximately 250 ft wide, with a footprint of approximately 3 acres. The ground surface elevation within the footprint of the historic plume boundary is approximately 130 ft msl. The topography of the land in this area is characterized as a broad, flat, and gently southward sloping glacial outwash plain. The land in the immediate vicinity of the FS-13 groundwater contamination is within the boundary of the MMR and is undeveloped apart from some base roads (i.e., Richardson Road and West Inner Road).

5.10.2.3 Initial Responses

The area of the pipeline release was investigated upon discovery in 1972 and a section of pipe was replaced. There were no initial responses for FS-13 groundwater.

5.10.2.4 Basis for Taking Action

The baseline risk calculations in the RI indicated that unless remedial action is undertaken, future residential exposure to groundwater contaminated with TMBs may present an unacceptable non-cancer hazard greater than regulatory thresholds. (AFCEE 1999c)

Since the extent of groundwater contamination in the FS-13 area is limited, the contaminants are not migrating (refer to Section 5.10.5.1), and no surface water bodies are located nearby, no ecological risks associated with FS-13 were identified in the RI (AFCEE 1999c).

5.10.3 Remedial Actions

The final remedy for the FS-13 plume was determined in the *Final Record of Decision for the CS-4, CS-20, CS-21 and FS-13 Plumes* (AFCEE 2000) which was signed on 18 February 2000.

The RAOs for the FS-13 groundwater plume as presented in the ROD (AFCEE 2000) and modified in the ESD (AFCEE 2011) are as follows:

- Prevent residential exposure to FS-13 groundwater with 1,2,4-TMB concentrations greater than the risk-based level of 17 µg/L.
- Prevent residential exposure to FS-13 groundwater with 1,3,5-TMB concentrations greater than the risk-based level of 17 µg/L.
- Restore usable groundwaters to their beneficial uses wherever practicable, within a timeframe that is reasonable given the particular circumstances of the site.

5.10.3.1 Remedy Selection and Implementation

The selected remedy in the ROD (AFCEE 2000) included the following components:

- Long-term monitoring of groundwater.
- Institutional controls to prevent the use of groundwater contaminated with FS-13 plume contaminants.
- Completion of CERCLA reviews every five years throughout the lifetime of the remedial action.

Since the remedy was selected in 2000, the following changes have occurred:

1. The institutional controls described in the ROD were further developed as described in a 2008 ESD (AFCEE 2008b). The ESD provides a more thorough description of the LUC Program, including a private well verification program that is being instituted for all the MMR groundwater sites.

2. A 2011 ESD for the IRP groundwater plumes (AFCEE 2011) clarified the inclusion of MNA as a component of the selected remedy for FS-13, slightly modified the phrasing of the RAOs which is reflected in Section 5.10.3, and added text regarding the MMR three-step process to achieve site closure.

Plume monitoring data collected under the LTM program are used to assess whether the remedial objectives are being met, remediation is progressing as expected, and to identify and assess optimization opportunities. The data collected under the FS-13 LTM program are presented to the regulatory agencies through the Technical Update meeting process and documented in project notes.

As part of the LUC process specified in the ROD and subsequent ESD (AFCEE 2000, 2008b), a private well verification survey was completed for FS-13 in March 2013 (AFCEC 2013). This private well verification survey concluded that no active or inactive water-supply or irrigation wells are located within the FS-13 LUC area. Additionally no private residential wells exist at FS-13. Therefore, there is no current or future risk of exposure to groundwater via actively used wells or wells that may be re-

activated in the future. LUCs are in place to prevent the future installation of a water-supply well within the FS-13 LUC area without prior notification to the Air Force.

5.10.3.2 Remedy Operation & Maintenance

Prior evaluations have concluded that TMB contamination in FS-13 groundwater is not migrating (AFCEE 2012b, 2005). Therefore, routine groundwater monitoring at FS-13 is no longer conducted. Direct push drilling is used to periodically sample groundwater at FS-13 in order to evaluate if 1,2,4-TMB and 1,3,5-TMB concentrations in groundwater have reached cleanup levels and site closure can proceed (AFCEE 2012b).

The periodic LTM costs associated with ongoing remedial action at FS-13 are generally consistent with those predicted at the time of remedy selection (with consideration for savings associated with optimization initiatives such as less frequent sampling as was assumed at the time of the remedy selection) and do not indicate potential remedy problems.

5.10.4 Progress Since the Last Five Year Review

Per the EPA guidance document (EPA 2001), this section summarizes the progress made on the specific recommendations and follow-up actions presented in the prior third CERCLA Five Year Review (AFCEE 2008a). For the FS-13 groundwater plume, the recommendations and follow-up actions were:

1) Section 4.1 of the third Five Year Review recommended that a screening level VI evaluation be completed for each IRP groundwater site. The objective of the VI evaluation was to determine if a VI exposure pathway exists at a particular site, and if so, complete a screening level evaluation to determine if VI risk above target levels is likely or unlikely.

2) The RAOs in the ROD required that the Air Force “prevent or reduce residential exposure”. The third Five Year Review recommended that the RAOs be modified to eliminate the word “reduce” to better ensure long-term protectiveness.

Progress since the last Five Year Review against these recommendations and follow-up actions is as follows:

1) A VI evaluation was completed for the 16 IRP groundwater sites at the MMR as documented in the *Final 2011 MMR Vapor Intrusion Evaluation Technical Memorandum* (AFCEE 2012a) including FS-13. The VI evaluation indicated the VI exposure pathway is insignificant at FS-13 and no further monitoring or data collection is needed specific to VI at FS-13. However, as part of the ongoing remedial actions at FS-13, AFCEC will continue to monitor the nature and extent of the FS-13 groundwater contamination under the LTM program and will re-evaluate the VI exposure pathway if conditions change such that VI could be a concern.

2) The *Final Explanation of Significant Differences for CS-4, CS-20, CS-21, FS-13, FS-28, and FS-29 Groundwater Plumes* (AFCEE 2008b) was signed on 26 September 2008 and included the requirement to complete the private well verification portion of the LUCs within three years of the signing of the ESD. Although FS-13 is located entirely on-base and no private residential wells are present, a well verification effort was completed following AFCEC's guidance (AFCEE 2008c) that concluded that no active or inactive water-supply wells are located within the FS-13 LUC area that could act as exposure pathways to FS-13 groundwater contamination (AFCEC 2013).

3) The 2011 ESD for the IRP groundwater plumes (AFCEE 2011) modified the phrasing of the RAOs to remove the word "reduce". The revised RAOs are presented in Section 5.10.3.

5.10.5 Five Year Review Process

5.10.5.1 Data Review

The FS-13 LTM program formerly (through 2004) included annual sampling of six monitoring wells in and downgradient of the FS-13 plume to document the natural attenuation of plume contaminants. Data collected over the course of the LTM program

indicated that the COCs were not mobile and contamination had not migrated downgradient. When the LTM network was last sampled in November 2004, the maximum concentrations of 1,2,4-TMB and 1,3,5-TMB in FS-13 groundwater were 383 µg/L and 143 µg/L, respectively (AFCEE 2005).

AFCEE submitted a request to the regulatory agencies on 08 June 2005 to discontinue groundwater monitoring on the basis of a decreasing trend over a period of five years, the immobility of TMBs, and because human exposure to contaminated groundwater is restricted by institutional controls on the base. The EPA granted a conditional approval to cease monitoring (EPA 2005) and the FS-13 monitoring wells were abandoned in 2006. In order to implement the first step in the three-step process, AFCEC must collect monitoring data to evaluate: (a) whether the plume is attenuating as predicted; (b) the potential for short-term health effects due to exposures, and (c) when the selected remedy will attain the remediation goals in the ROD and/or ESD.

In April and May 2011, AFCEE installed two direct push vertical profile borings at FS-13 to re-evaluate current groundwater quality and assess remedial progress. The two direct push borings, shown as 03DP1112 and 03DP1113 on **Figure 5-10**, were installed close to the locations of the abandoned FS-13 wells where TMB concentrations remained in 2004 and within the historic plume footprint. Concentrations of 416 µg/L for 1,2,4-TMB and 160 µg/L for 1,3,5-TMB, were detected at the northern location (03DP1112); 1,2,4-TMB and 1,3,5-TMB were detected at 99 µg/L and 54 µg/L at the southern direct push location (03DP1113). The data collected at these two locations indicated concentrations of 1,2,4-TMB and 1,3,5-TMB remain above the calculated HEC of 17 µg/L at the sampling interval approximately 10 ft below the water table. Although these recent TMB concentrations are similar to, or slightly lower than what was reported in 2004, cleanup goals at FS-13 have not yet been reached (AFCEE 2012b). At the time of remedy selection, it was assumed that monitoring would continue at FS-13 for 20 years although it was acknowledged that the data available at the time of remedy selection was insufficient to make an accurate estimate of how long it would take to reach cleanup levels (AFCEE 2000). However, it was noted that contaminant concentrations at

FS-13 are expected to reach remedial goals long before the underlying CS-10 plume reaches cleanup levels. Direct push drilling will be used to complete vertical profiling at the same locations in approximately five years at FS-13 in order to evaluate if TMB concentrations in groundwater have reached cleanup levels and site closure can proceed (AFCEE 2012b).

5.10.5.2 Site Inspections

Refer to Section 3.5.

5.10.5.3 Interviews

Refer to Section 3.6.

5.10.6 Technical Assessment

The technical assessment component of the Five Year Review consists of evaluating the protectiveness of the remedy. The technical assessment is based on EPA guidance provided in Section 4.0 of the Comprehensive Five Year Review Guidance (EPA 2001).

5.10.6.1 Question A: Is the remedy functioning as intended by the decision documents?

Yes, the LTM activities and the completion of the well verification/well determination portion of the LUCs have resulted in the remedy functioning as intended by the decision documents. Operational costs are appropriate for the remedy. Monitoring and evaluation activities are conducted periodically continual and will be assessed in future Five Year Reviews.

5.10.6.2 Question B: Are the exposure assumptions, toxicity data, cleanup levels, and remedial action objectives (RAOs) used at the time of the remedy selection still valid?

Changes in Standards and To-Be Considered: There have been no changes in standards or TBC guidance. Since there is no MCL, MMCL, or MCP GW-1 standard for either 1,2,4-TMB or 1,3,5-TMB, a risk-based HEC of 17 µg/L was developed as a cleanup level for TMBs in FS-13 groundwater.

It is noted that MassDEP regulates TMBs as C_9-C_{10} aromatic hydrocarbons using the MassDEP VPH analytical method (MassDEP 2002). The MassDEP GW-1 standard for C_9-C_{10} aromatic hydrocarbons is 200 µg/L.

Changes in Exposure Pathways: There have been no changes to exposure pathways or land use of the site that would affect the protectiveness of the remedy. It is noted that since the VI exposure pathway was not considered in the RI, a screening evaluation has been completed and the VI pathway was found to be insignificant at FS-13 (AFCEE 2012a).

Changes in Toxicity and Other Contaminant Characteristics. There has been a change to the toxicity factor used to calculate the cleanup levels at FS-13.

The inhalation reference dose for 1,2,4-TMB has been updated since its use to calculate the HEC presented in the ROD (AFCEE 2000). Based on the new inhalation reference dose ($2x10^{-3}$ mg/kg-day) (EPA 2012) and following the same risk assessment methodology as presented in the ROD, the updated HEC is 19 µg/L. There are still no carcinogenic toxicity values or oral reference dose values available for 1,2,4-TMB. For 1,3,5-TMB, only an oral reference dose is available which results in an EPA RBC of 87 µg/L (at a HI of 1 and based on ingestion).

Since the cleanup level in the ROD (17 µg/L) is more stringent than the recalculated cleanup level using the updated toxicity information, this change in toxicity does not affect the protectiveness of the remedy or the appropriateness of the RAOs. However, these updated toxicity values for the TMBs (or values derived from future updates)

should be used when performing the residual risk assessment as part of the three-step process to achieve site closure (AFCEE 2011).

Changes in Risk Assessment Methods: There were no changes in risk assessment methodology.

Review of RAOs: The RAOs developed for the final ROD (AFCEE 2000) and revised in the 2011 ESD (AFCEE 2011) are appropriate and remain valid.

5.10.6.3 Question C: Has any other information come to light that could call into question the protectiveness of the remedy?

No.

5.10.7 Issues, Recommendations, and Follow-Up Actions

No specific recommendation or follow-up actions have been identified. However, the topic of emerging contaminants should be monitored as it relates to groundwater at FS-13 and the MMR.

5.10.8 Protectiveness Statement

The remedy for the FS-13 groundwater plume is protective of human health and the environment. Remediation is progressing as expected. The LUCs are in place and are functioning as intended. Through natural attenuation processes, groundwater cleanup levels are expected to be reached over time and monitoring data indicate the contaminants are not migrating beyond the FS-13 area.

5.10.9 References

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5.11 FUEL SPILL-28 (FS-28) GROUNDWATER

The FS-28 plume is a dissolved-phase groundwater plume (**Figure 5-11A**) that is defined as the extent of groundwater containing the FS-28 plume COC, EDB, at concentrations exceeding the MMCL of 0.02 µg/L.

5.11.1 Site Chronology

1993: The FS-28 plume was first discovered in 1993 beneath the leading edge of the CS-4 plume (AFCEE 1999c) and was subsequently investigated as a separate groundwater plume.

1996: EDB was found to be upwelling and discharging into the Coonamessett River at detectable levels (AFCEE 1999c).

1997: Completed the SWOU RI which included FS-28 (AFCEE 1999b).

1997-1999: Time-critical and non-time-critical removal actions were implemented to reduce the discharge of EDB in groundwater to the Coonamessett River surface water (AFCEE 1999a, 1999c).

2000: A feasibility study, proposed plan, and ROD were completed (AFCEE 2000a, 2000b, 2000c). The final remedy consisted of continued operation of the existing remedial system installed under the time-critical and non-time-critical removal actions. Therefore, the remedy was in place at the time of the signature of the ROD.

2008: An ESD was prepared to further describe the institutional controls associated with the remedy (AFCEE 2008b)

2011: An ESD was prepared that clarified the inclusion of MNA as a component of the selected remedy, slightly modified the phrasing of the RAOs, and added text regarding the MMR three-step process to achieve site closure (AFCEE 2011a)

5.11.2 Background

5.11.2.1 History of Contamination

The FS-28 plume is detached from its source area which remains unidentified. It is speculated that contamination was released at the ground surface from a fuel spill or spills on the MMR, migrated through the vadose zone, and entered the groundwater at the water table. The dissolved phase contamination was then carried downgradient in groundwater in a southerly direction.

5.11.2.2 Physical Characteristics, Land and Resource Use

Based on the most recent groundwater monitoring data collected in 2012, the main body of the FS-28 plume is approximately 4,300 ft long, up to 1,500 ft wide, and up to 100 ft thick in the deeper portion of the aquifer. In addition to the main body of the FS-28 plume, two detached lobes exist to the south of the main plume. The smaller of the two lobes is located approximately 750 ft south of the main plume; this smaller lobe is approximately 450 long, up to 100 ft wide, and only 10 to 20 ft thick in the shallower portion of the aquifer. The larger of the two lobes is located farther to the south, deeper in the aquifer, and is approximately 3,000 ft long, up to 300 ft wide, and up to 75 ft thick in the aquifer. The plan view extent of the FS-28 plume is shown on **Figure 5-11A**. The footprint of the FS-28 plume was approximately 241 acres in 2007 and approximately 116 acres in 2012.

Land above the FS-28 plume is used for residential, limited commercial/industrial, agricultural, and recreational purposes. Recreational fishing is popular in this area, particularly in Coonamessett Pond, a portion of which is located above the plume footprint (**Figure 5-11A**). Agricultural use of land in the area of the FS-28 plume includes fruit and vegetable farms, and cultivation and harvesting of cranberries from the lowland bogs or river valleys. The Town of Falmouth Coonamessett Water Supply Well (CWSW) is located to the south of the western arm of Coonamessett Pond (**Figure 5-11A**). This well is a PWSW that operates at approximately 550 gpm. The

land above the FS-28 plume can be characterized as a broad, flat, gently southward sloping glacial outwash plain. Within the footprint of the plume, the maximum and minimum ground surface elevations are 82 ft msl and 18 ft msl, respectively.

5.11.2.3 Initial Responses

The summary of the initial responses is as follows:

Non-CERCLA Actions:

In 1996, AFCEE completed construction of a wellhead carbon filtration system for the CWSW as a precaution, even though there was no evidence that this water supply well had been affected by the FS-28 plume. This wellhead carbon filtration system was subsequently dismantled in 2004 when water from CWSW was connected to the Town of Falmouth's Crooked Pond treatment facility that is also installed with a wellhead carbon filtration system. In 1997 and 1998, in an effort to protect public health and eliminate the threat of EDB in private wells near homes above and/or near the FS-28 plume, AFCEE installed town water mains and piping to over 200 residents of the Hatchville area of Falmouth. Ten irrigation wells were also installed for cranberry growers along the river system to replace their previous use of surface water. Detectable levels of EDB in the Coonamessett River surface water as a result of the plume discharge led to the cranberry farmers being compensated for lost crops in 1997, 1998, 1999, and 2005 by the DoD. Based on an agreement that is in place with the FS-28 stakeholder group (comprised of EPA, MassDEP, MassDPH, and Cape Cod Cranberry Growers Association), the Coonamessett River cranberry crop will be considered suitable for market if EDB concentrations in surface water remain below the MMCL. The crop has been considered suitable for market since 2005.

CERCLA Actions:

AFCEE installed the FS-28 ETD system in 1997 (using a single deep extraction well – 69EW0001) under the CERCLA time-critical removal action process to capture the majority of the plume mass at Hatchville Road and to minimize upwelling of the plume into the Coonamessett River system (AFCEE 1999c).

In April 1999, AFCEE implemented a non-time-critical removal action which added additional extraction capacity to the system in the form of SWPs in an attempt to capture EDB-contaminated groundwater prior to its discharge to the Coonamessett River and neighboring cranberry bogs (AFCEE 1999a). Installation and operation of this SWP system was successful in improving water quality in the river and bogs. In addition, AFCEE installed berms and sheet piles as part of this non-time critical removal action. The berms and sheet piles were designed to separate the Coonamessett River from the surrounding cranberry bogs.

During 2007, the FS-28 ETD system was further expanded through optimization with the installation of a second extraction well (69EW0002) to remediate a deeper leading edge lobe of the plume identified to the south of both 69EW0001 and the SWP system (AFCEE 2008c).

Since system startup in 1997, the operation of the FS-28 remedial system has been optimized several times and is currently operating at a total flow rate of 600 gpm from the two FS-28 extraction wells (550 gpm from 69EW0001 and 50 gpm from 69EW0002; the SWPs were permanently shutdown in 2010 because they were no longer contributing to aquifer restoration). Further details regarding the FS-28 remedial system can be found in the 2012 O&M Plan (AFCEE 2012c).

An ESD for the IRP groundwater plumes was submitted in September 2011 that clarified the inclusion of MNA as a component of the selected remedy, slightly modified the phrasing of the RAOs, and updated the steps to achieve site closure (i.e., the three-step process) (AFCEE 2011a).

5.11.2.4 Basis for Taking Action

The baseline cancer risk calculations in the RI indicated that unless remedial action is undertaken, future residential exposure to contaminated groundwater may present an excess lifetime cancer risk greater than the acceptable MassDEP threshold of $1x10^{-5}$ and the acceptable EPA range of $1x10^{-4}$ to $1x10^{-6}$. In addition, acceptable risk thresholds were exceeded for cranberry workers and recreational waders (adult and child) exposed to surface water, and consumers of fish caught in the Coonamessett River (AFCEE 2000a).

Ecological risks associated with the FS-28 groundwater plume were evaluated during the RI and no significant risk was identified (AFCEE 2000a).

5.11.3 Remedial Actions

The final remedy for the FS-28 plume was determined in the *Final Record of Decision for the Fuel Spill-28 and Fuel Spill-29 Plumes* (AFCEE 2000a) which was signed on 23 October 2000.

The RAOs for the FS-28 groundwater plume as presented in the ROD (AFCEE 2000a) and modified in the ESD (AFCEE 2011a) are as follows:

- Prevent residential exposure to FS-28 groundwater with EDB concentrations greater than the MMCL of 0.02 µg/L.
- Restore usable groundwaters to their beneficial uses wherever practicable, within a timeframe that is reasonable given the particular circumstances of the site.
- Prevent worker contact and child and adult wader contact with Coonamessett River water containing unacceptable concentrations of EDB*.
- Prevent ingestion of fish exposed to Coonamessett River water containing unacceptable concentrations of EDB*.

  * Note that subsequent to the completion of the ROD, a screening-level human health risk evaluation was conducted to examine the potential for imminent human health risks from exposure to surface water containing EDB (Appendix D of AFCEE 2003). This screening level evaluation for EDB resulted in the development of an RBC for EDB of 7.71 µg/L in surface water at a target risk of 1×10^{-3} (constituting the potential for "imminent human health risks").

5.11.3.1 Remedy Selection and Implementation

The selected remedy in the ROD (AFCEE 2000a) included the following components:

- Continued operation of the FS-28 ETD system including the deep extraction well (69EW0001), the 204 SWP system and the CWSW wellhead treatment system with treatment via GAC. At the time the ROD was prepared (2000), modeling indicated the aquifer restoration timeframe would be approximately 18 years (i.e., by 2018) through the operation of 69EW0001 and the SWPs.
- Extracted water would be treated with GAC. Treated water could be used, if necessary for cranberry operations in the upper bogs. Berms and vinyl sheet piles would separate cranberry bogs from the river.
- Continue to supply uncontaminated water to the agricultural users on the Coonamessett River.
- Institutional controls to mitigate exposure to humans from EDB-contaminated groundwater. In 1999, the Falmouth BOH adopted water well regulations to minimize the risk of exposure to groundwater contamination.
- Engineering controls to mitigate exposure to humans from EDB-contaminated groundwater. Residents potentially impacted by the plume are connected to a public water supply.
- Monitoring of the plume and performance monitoring of the treatment systems. Ecological sampling would also be conducted as part of the selected alternative.
- Completion of CERCLA reviews every five years throughout the lifetime of the remedial action.

Since the remedy was selected in 2000, the following changes have occurred:

1) A second extraction well (69EW0002) was added to the ETD system as an optimization initiative. This well was added in 2007 to contain and capture the deep leading edge plume lobe located to the south of the main EDB plume (**Figure 5-11A**).

2) The SWP system was shut down for an interim basis in November 2008 and permanently in February 2010. An optimization evaluation determined that the SWP system had been successful in remediating the portion of the plume it was intended to address and in reducing plume discharge to the river. Rather than

continue to operate the SWP system inefficiently, it was agreed that the attenuation of the remaining residual EDB contamination will be monitored.

3) The CWSW wellhead treatment system was shutdown and subsequently dismantled in 2004 when water from the CWSW was connected to the Town of Falmouth's Crooked Pond treatment facility.

4) The institutional controls described in the ROD were further developed as described in a 2008 ESD (AFCEE 2008b). The ESD provides a more thorough description of the LUC program, including a private well verification program that is being instituted for all the MMR groundwater sites.

5) Removal of the vinyl sheet piles (475 linear ft) at a former cranberry bog owned by the Town of Falmouth (referred to as the 300 Committee Wetland) was completed in August 2010 at the request of the property owner since the bog is no longer used for cranberry farming.

6) A 2011 ESD for the IRP groundwater plumes (AFCEE 2011a) clarified the inclusion of MNA as a component of the selected remedy for FS-28, slightly modified the phrasing of the RAOs, and added text regarding the MMR three-step process to achieve site closure.

Remedial system performance monitoring data and long-term plume monitoring data collected under the SPEIM/LTM program are used to assess: (i) whether the remedial objectives and system performance metrics are being met; (ii) whether remediation is progressing as expected; and (iii) to identify and assess optimization opportunities. The data collected under the SPEIM/LTM program are presented to the regulatory agencies through the Technical Update meeting process and documented in annual SLRs.

As part of the LUC process specified in the ROD and subsequent ESD (AFCEE 2000a, 2008b), a private well verification survey was completed for FS-28 (and the Southwest Plumes) between April 2009 and August 2011 (AFCEE 2012f). This private well verification survey consisted of outreach to 497 parcels. Responses were obtained from

100 percent of the property owners within the LUC area and identified a total of 22 properties associated with FS-28 that have one or more private wells that are used as a non-potable water source. No private wells that are used as a potable water supply were identified. Technical evaluations were completed for each private irrigation well to determine the future sampling frequency and/or re-evaluation frequencies (if necessary). No private wells used for irrigation were identified that present an unacceptable exposure risk from the FS-28 groundwater. One irrigation well located north of Hatchville Road, to the west of the FS-28 plume, has been regularly monitored by AFCEC since 1998 because it is used to supply irrigation water for hydroponic food cultivation. This well will continue to be monitored under AFCEC's LUC Program. In the event that new private well information is obtained or plume monitoring data indicate a change to the CSM at FS-28, AFCEC will perform the necessary well determinations at the time the information becomes available.

In addition, between February and July 2013, AFCEC contacted the owners of private wells that were determined to be non-operational or disconnected to confirm that the wells have not been restarted. During this 2013 outreach, AFCEC determined that one of the 16 private wells that were identified during the initial well verification effort as non-operational or disconnected has been returned to service for outdoor uses. A technical evaluation was completed for this private well and based upon a review of SPEIM data and private well sampling data there is no current risk of exposure to FS-28 groundwater through the intermittent use of this private well for outdoor purposes. The technical evaluation for the private well that was restarted in 2013 is included in **Appendix D**.

The status of non-operational private wells within the FS-28 LUC area will continue to be tracked. AFCEC will distribute a mailing, on an annual basis, to property owners within the LUC area that have non-operational wells for which no technical evaluation could be completed due to lack of known well depths and inability to sample. The intent of the annual mailing is to remind these property owners that they should contact AFCEC for a technical evaluation, which may include sampling, in the event their well is put back into service. In addition to these annual mailings, AFCEC will perform outreach as part of

future Five Year Reviews to each of the property owners requiring confirmation of the non-operational status of their wells (AFCEC 2013b)

5.11.3.2 Remedy Operation & Maintenance

The FS-28 remedial system is operated and maintained under an approved O&M Plan (AFCEE 2012c). The O&M Plan is updated on an annual basis and includes operational requirements, a summary of the operational history of the systems, and details of any system modifications, optimizations, or improvements. While occasional operational issues are identified, these issues have been, and continue to be, addressed in a timely and effective manner such that O&M associated with the remedy is considered effective at achieving the remedy goals. Operational issues are identified in O&M monthly reports and system performance and reliability is reported in the annual SLRs.

The annual SPEIM/LTM/O&M costs associated with ongoing remedial action at FS-28 are generally consistent with those predicted at the time of remedy selection (with consideration for savings associated with optimization initiatives) and do not indicate potential remedy problems.

5.11.4 Progress Since the Last Five Year Review

Per the EPA guidance document (EPA 2001), this section summarizes the progress made on the specific recommendations and follow-up actions presented in the prior third CERCLA Five Year Review (AFCEE 2008c). For the FS-28 groundwater plume, the recommendations and follow-up actions were:

1) Section 4.1 of the third Five Year Review recommended that a screening level VI evaluation be completed for each IRP groundwater site. The objective of the VI evaluation was to determine if a VI exposure pathway exists at a particular site, and if so, complete a screening level evaluation to determine if VI risk above target levels is likely or unlikely.

2) Section 4.3 of the third Five Year Review recommended that, in order to ensure long term protectiveness, all groundwater sites with off-base plume areas must undergo the well verification process as described in AFCEC's guideline titled *Verification, Decommissioning, and Documentation Guidelines for Private Wells in Areas of Potential Concern* (AFCEE 2008d). It was recommended that this requirement be codified in an ESD for those off-base groundwater sites with RODs that do not currently contain the well verification language as part of the required LUCs. For off-base groundwater sites without final RODs at the time of the third Five Year Review (AV and CS-10), the well verification language should be included in the LUC requirements presented in the Final RODs.

3) The RAOs in the ROD required that the Air Force "prevent or reduce residential exposure". The third Five Year Review recommended that the RAOs be modified to eliminate the word "reduce" to better ensure long-term protectiveness.

Progress since the last Five Year Review against these recommendations and follow-up actions is as follows:

1) A VI evaluation was completed for the 16 IRP groundwater sites at the MMR as documented in the *Final 2011 MMR Vapor Intrusion Evaluation Technical Memorandum* (AFCEE 2012b) including FS-28. The VI evaluation indicated the VI exposure pathway is either incomplete or insignificant at FS-28 and no further monitoring or data collection is needed specific to VI at FS-28. However, as part of the ongoing remedial actions at FS-28, AFCEC will continue to monitor the nature and extent of the FS-28 groundwater contamination under the SPEIM program and will re-evaluate the VI exposure pathway if conditions change such that VI could be a concern.

2) The *Final Explanation of Significant Differences for CS-4, CS-20, CS-21, FS-13, FS-28, and FS-29 Groundwater Plumes* (AFCEE 2008b) was signed on 26 September 2008 and included the requirement to complete the private well verification portion of the LUCs within three years of the signing of the ESD. This well verification effort was completed in 2011 and concluded that no private

wells that were identified present an unacceptable exposure risk from the FS-28 groundwater (AFCEE 2012f). Further details of the well verification process and findings are included in Section 5.11.3.1

3) The 2011 ESD for the IRP groundwater plumes (AFCEE 2011a) modified the phrasing of the RAOs to remove the word “reduce”. The revised RAOs are presented in Section 5.11.3.

5.11.5 Five Year Review Process

5.11.5.1 Data Review

The MMR SPEIM program was developed to monitor plume changes and to ensure the effective operation of the AFCEC groundwater remediation systems at the MMR. These objectives are met through monitoring of selected media (i.e., groundwater, surface water) within and outside the plume boundaries, treatment plant monitoring, and groundwater flow and transport modeling. The data collected under the SPEIM program are continually assessed by a team of on-site professional staff and the results of these assessments are presented to the regulatory agencies initially during Technical Update meetings and then through technical memoranda or project note deliverables, if warranted, based on the results of the data evaluation or to address particular plume issues.

In addition, AFCEC prepares annual SLRs for the groundwater plumes that are being addressed through active treatment. The purpose of these SLRs is to document the results of sampling activities conducted at each plume under the SPEIM program The SLRs also include: (i) a summary of all major events and optimizations completed at the plume; (ii) O&M-related system performance information such as contaminant mass removal/air emissions, system flow rate summaries, and downtime summaries; and (iii) all relevant technical assessment documentation completed during the annual reporting period as attachments or by reference. The SLRs are provided to the broad stakeholder group for each plume including Federal (EPA) and State (MassDEP, MassDPH) regulatory agencies, town departments (such as the BOHs, Departments of

Public Work, Water Departments, and/or Conservation Commissions), affected property owners, and other interested parties. The SLRs are publically available in the IRP Administrative Record and copies are maintained at the local town libraries.

In addition to the annual SLRs prepared for FS-28 during this Five Year Review period (AFCEC 2013c, AFCEE 2012e, 2011b, 2010b, 2009a, 2008f), the following technical deliverables were prepared that assessed system performance or presented the results of optimization evaluations:

- *Fuel Spill-28 2007 Annual SPEIM Data Presentation Project Note* (AFCEE 2008a).
- *Fuel Spill-28 2008 Surface Water Monitoring Optimization Project Note.* (AFCEE 2008e).
- *Fuel Spill-28 2008 Extraction, Treatment, and Discharge System and SPEIM Network Optimization Project Note.* (AFCEE 2009b).
- *Coonamessett Water Supply Well Sentry Well Sampling Optimization Project Note.* (AFCEE 2010d)
- *Fuel Spill-28 2009 Triennial SPEIM Data Presentation Project Note.* (AFCEE 2010c).
- *Fuel Spill-28 2009/2010 Annual/Semiannual SPEIM Data Presentation Project Note.* (AFCEE 2010a)
- *Fuel Spill-28 2011 Annual SPEIM Data Presentation Project Note.* (AFCEE 2012d).
- *Fuel Spill-28 2012 Triennial SPEIM Data Presentation Project Note* (AFCEE 2012a).
- *Fuel Spill-28 2013 Annual SPEIM Data Presentation Project Note* (AFCEC 2013a).

While additional details are provided in the documents listed above, the primary findings and conclusions from these system performance evaluations at FS-28 are as follows:

1. The FS-28 remedial system removed approximately 1.5 lbs of EDB through the treatment of approximately 1.5 billion gallons of groundwater during this Five Year Review period. In total, the FS-28 ETD system has treated

approximately 5.2 billion gallons of contaminated groundwater and removed approximately 14.83 lbs of EDB since system startup in October 1997 through December 2012.

2. A comparison of the FS-28 plume boundary at the start and end of this Five Year Review period (i.e., 2007 versus 2012) is included on **Figure 5-11B**. EDB concentration trends at select groundwater monitoring wells are shown in **Figure 5-11C**, **Figure 5-11D**, and **Figure 5-11E**. The highest EDB detection in the FS-28 plume between 2007 and 2012 was 2.54 µg/L collected from monitoring well 69MW1283B in 2007. The five highest EDB detections at FS-28 in 2007 ranged from 1.18 to 2.54 µg/L. In 2012, the five highest EDB detections at FS-28 ranged from 0.267 to 0.933 µg/L.

3. Through a combination of active treatment and natural attenuation, plume remediation is progressing as expected. A review of the SPEIM data indicates that the plume extent and concentrations are declining as expected at the time of remedy selection. Therefore, the restoration timeframe presented in the ROD (i.e., approximately 2018) should be met or approached if concentrations continue to decline at the rate observed over the past five to seven years.

4. Detectable concentrations of EDB have been reported in Coonamessett River surface water samples in the past which has led to the DoD compensating the cranberry farmers for loss of crop (most recently in 2005). An agreement is in place with the FS-28 stakeholder group (EPA, MassDEP, MassDPH, and Cape Cod Cranberry Growers Association) that the Coonamessett River cranberry crop will be considered suitable for market if EDB concentrations in surface water remain below MMCLs. EDB was not detected above the MMCL during this Five Year Review period and no EDB was detected in surface water during two sampling rounds at 11 monitoring locations in 2012. Since the main EDB plume is being hydraulically captured by 69EW0001, significant discharge of EDB to Coonamessett River surface water from

groundwater is not expected in the future. In addition, EDB has never been detected in surface water samples collected from the nearby kettle ponds (i.e., Coonamessett Pond, Deep Pond, or Round Pond) (**Figure 5-11A**).

5. The potential for ecological impacts associated with the discharge of treated water from the FS-28 ETD system to the Coonamessett River was monitored between system startup in October 1997 and September 2007. Based on an analysis of the considerable volume of water quality data that was collected by AFCEE, it was demonstrated that any ecological impacts of the FS-28 remedial system discharge to surface water are considered to be insignificant. Therefore, the routine monitoring for water quality parameters (i.e., temperature, pH, and dissolved oxygen) at the Coonamessett River was eliminated in 2008 (AFCEE 2008e).

6. The Town of Falmouth CWSW is located to the south of the western arm of Coonamessett Pond (**Figure 5-11A**). This well is a PWSW that operates at approximately 550 gpm. Monitoring data indicate the top of the FS-28 plume is located at least 100 ft below the CWSW screen and there is no evidence indicating the plume is impacting the water quality within the zone of contribution to the CWSW based on the results of a sentry well sampling program.

7. Plume monitoring under AFCEC's SPEIM/LTM program should continue at FS-28 to provide the necessary data to manage potential exposure risks, assess remedial progress, and evaluate optimization opportunities.

5.11.5.2 Site Inspections

Refer to Section 3.5.

5.11.5.3 Interviews

Refer to Section 3.6.

5.11.6 Technical Assessment

The technical assessment component of the Five Year Review consists of evaluating the protectiveness of the remedy. The technical assessment is based on EPA guidance provided in Section 4.0 of the Comprehensive Five Year Review Guidance (EPA 2001).

5.11.6.1 Question A: Is the remedy functioning as intended by the decision documents?

Yes, the startup of the ETD system in 1997, expansion of the system in 1999 and 2007, completion of the ROD in 2000 and ESDs in 2008 and 2011, continued operation of the remedial system, and completion of the well verification/well determination portion of the LUCs in 2011 have resulted in the remedy functioning as intended by the decision documents. The remedial system is performing as expected. Through the combination of the active treatment by the remedial system and natural attenuation processes groundwater cleanup levels are expected to be achieved or approached within the timeframe approximated in the ROD (i.e., by 2018). Operational costs are appropriate for the remedy and a robust optimization program continues to reduce future costs. Monitoring and evaluation activities are continual and well-documented.

5.11.6.2 Question B: Are the exposure assumptions, toxicity data, cleanup levels, and remedial action objectives (RAOs) used at the time of the remedy selection still valid?

Changes in Standards and To-Be Considered: There have been no changes in standards or TBC guidance.

Changes in Exposure Pathways: There have been no changes to exposure pathways or land use of the site that would affect the protectiveness of the remedy. It is noted that since the VI exposure pathway was not considered in the RI, a screening evaluation has been completed and the VI pathway was found to be incomplete or insignificant (AFCEE 2012b).

Changes in Toxicity and Other Contaminant Characteristics. There have been no changes in the toxicity factors or other contaminant characteristics for the FS-28 groundwater COC (EDB) during this Five Year Review period and the MMCL remains at 0.02 µg/L.

The RBC for human health exposure to EDB in FS-28 surface water of 7.71 µg/L for a target risk of 1 x 10^{-3} (i.e., imminent human health risk) that was developed in 2003 (AFCEE 2003) has been recalculated using updated toxicity information. In 2004, the carcinogenic toxicity value for EDB for oral exposure was revised downward by more than an order of magnitude (EPA 2013). The similar approach and exposure scenarios used in 2003 were followed using the updated toxicity values and the updated lowest RBC for EDB in FS-28 surface water is 328 µg/L (under the "imminent risk to human health" scenario and driven by the consumption of fish from the surface water body).

The highest detected EDB concentration in FS-28 surface water was 1.12 µg/L in 1998 in a sample collected from a cranberry bog ditch adjacent to the former location of the SWP system. Due to the success of the SWP system, EDB detections in surface water became less frequent, and when detected, concentrations were lower. In 2012, no EDB was detected in Coonamessett River surface water.

These updated toxicity values (or values derived from future updates) should be used when performing the residual risk assessment as part of the three-step process to achieve site closure (AFCEE 2011a).

Changes in Risk Assessment Methods: There were no changes in risk assessment methodology.

Review of RAOs: The RAOs developed for the final ROD (AFCEE 2000) and revised in the 2011 ESD (AFCEE 2011a) are appropriate and remain valid.

5.11.6.3 Question C: Has any other information come to light that could call into question the protectiveness of the remedy?

No.

5.11.7 Issues, Recommendations, and Follow-Up Actions

No specific recommendation or follow-up actions have been identified. However, the topic of emerging contaminants should be monitored as it relates to groundwater at FS-28 and the MMR.

5.11.8 Protectiveness Statement

The remedy for the FS-28 groundwater plume is protective of human health and the environment. The remedial system is performing as expected. The LUCs are in place and are functioning as intended. Through the combination of the active treatment by the remedial system and natural attenuation processes, groundwater cleanup levels are expected to be achieved within the timeframe approximated in the ROD, which was considered reasonable given the particular circumstances of the site.

5.11.9 References

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5.12 FUEL SPILL-29 (FS-29) GROUNDWATER

The FS-29 plume is a dissolved-phase groundwater plume that is defined as the extent of groundwater containing the COC, EDB, at concentrations exceeding its MMCL of 0.02 µg/L. The remaining COC, CCl_4, is detected sporadically at concentrations near its MCL of 5 µg/L, and is generally co-located with the EDB contamination.

5.12.1 Site Chronology

1998: The FS-29 plume was discovered during the RI (AFCEE 1999b).

1999: The feasibility study was completed in June 1999 (AFCEE 1999a).

2000: The proposed plan was released to the public in February 2000 (AFCEE 2000b), and the ROD was submitted in October 2000 (AFCEE 2000a).

2004: Completion of the final wellfield design consisting of two FS-29 extraction wells that were installed as part of the Southwest Plumes remedial system, which was designed to collectively remediate the CS-4, CS-20, CS-21, and FS-29 groundwater plumes (AFCEE 2004) (**Figure 5-12A**).

2006: Remedy in place was achieved in September 2006 with the startup of the FS-29 treatment system (AFCEE 2008d).

2008: An ESD was submitted to document changes to the selected remedy for FS-29 related to the expected extent of plume capture and further described the institutional controls associated with the remedy (AFCEE 2008b).

2011: An ESD was prepared that clarified the inclusion of MNA as a component of the selected remedy, slightly modified the phrasing of the RAOs, and added text regarding the MMR three-step process to achieve site closure (AFCEE 2011b).

5.12.2 Background

5.12.2.1 History of Contamination

The FS-29 plume is detached from its source area which remains unidentified. It is speculated that contamination was released at the ground surface from a spill or release on the MMR, migrated through the vadose zone, and entered groundwater at the water table. The dissolved phase contamination was then carried downgradient in groundwater in a south-southwesterly direction.

5.12.2.2 Physical Characteristics, Land and Resource Use

Based on groundwater monitoring data collected in 2012, the FS-29 plume is approximately 2,500 ft long, has a maximum width of approximately 600 ft, and is up to 40 ft thick in the aquifer (**Figure 5-12A**). The footprint of the FS-29 plume was approximately 211 acres in 2007, and was approximately 28 acres in 2012 (**Figure 5-12B**).

The land above the northernmost portion of the FS-29 plume is undeveloped woodlands used for recreational purposes (hiking, biking, hunting, etc.) within the CWMA, which is managed by the MDFW (**Figure 5-12A**). The land above the majority of the FS-29 plume is residential and recreational (The Golf Club of Cape Cod). This golf club has a private irrigation well (69IG0018) located near the FS-29 plume. EDB and CCl_4 have never been detected in samples collected from irrigation well 69IG0018.

The eastern portion of the FS-29 plume is located within a broad, flat, gently sloping glacial outwash plain. The western portion of the plume travels into a hummocky north-south trending ridge of moraine glacial deposits. Within the footprint of the plume, the maximum and minimum ground surface elevations are 154 ft msl and 52 ft msl, respectively.

5.12.2.3 Initial Responses

A summary of the initial responses is as follows:

Non-CERCLA Actions: None.

CERCLA Actions:

FS-29 Groundwater Plume: Following the 1998 RI (AFCEE 1999b), a feasibility study was completed in 1999 (AFCEE 1999a). Following the feasibility study, AFCEE and regulatory agencies agreed to present a new preferred alternative (Alternative 7) in the proposed plan issued in 2000 (AFCEE 2000b), which provided for expedited cleanup in the central portion of the plume. However, the preferred alternative for FS-29 was changed to Alternative 3 in response to public input. Therefore, the selected remedy for FS-29 as specified in the ROD was Alternative 3: conduct additional site characterization and groundwater modeling to better define the plume; design, construct, and operate a treatment system to hydraulically capture and treat plume contaminants; conduct performance monitoring of the FS-29 plume and remedial system and ecological sampling to monitor the impacts of the treatment system on the environment; and implement institutional controls (AFCEE 2000a).

The FS-29 remedial system consisted of two extraction wells (80EW0001 and 80EW0002) that began operation on 11 September 2006 at a design extraction rate of 525 gpm (**Figure 5-12A**). Extracted groundwater was treated by GAC in the centrally-located HATF and the treated water was returned to the aquifer through reinjection wells, an infiltration trench, and an infiltration gallery. The last operating FS-29 extraction well (80EW0001) was shut down in September 2010 because it was no longer contributing to cleanup of the FS-29 plume (AFCEE 2010a) (i.e., no EDB was detected in the extraction well influent and CCl_4 concentrations were low). Further details regarding the FS-29 remedial system can be found in the 2012 O&M Plan (AFCEE 2012b).

An ESD was submitted in 2008 to document changes to the remedy for FS-29 (AFCEE 2008b) including the wellfield design/cleanup strategy; the ESD also further described the institutional controls (i.e., the private well verification program). The primary difference between the cleanup strategy identified in the ROD and the final design is that the selected alternative presented in the ROD anticipated that the entire FS-29 plume would be hydraulically captured by the remedial system; however, the final design allowed the groundwater contamination in the downgradient leading edge of FS-29 to reach cleanup levels through natural attenuation instead of through active treatment. While analyzing various designs for system performance, effectiveness, property access issues, and other constraints, the final design for FS-29 was developed to meet the RAOs described in Section 5.12.3, while allowing for a relatively small portion of the plume to attenuate naturally.

An ESD for the IRP groundwater plumes was submitted in September 2011 that clarified the inclusion of MNA as a component of the selected remedy, slightly modified the phrasing of the RAOs, and updated the steps to achieve site closure (i.e., the three-step process) (AFCEE 2011b).

5.12.2.4 Basis for Taking Action

The baseline cancer risk calculations in the SWOU RI indicated that unless remedial action is undertaken, future residential exposure to EDB and CCl_4 in groundwater may present an excess lifetime cancer risk greater than the acceptable MassDEP threshold of $1x10^{-5}$ and the acceptable EPA range of $1x10^{-4}$ to $1x10^{-6}$. Ecological risks associated with the FS-29 groundwater plume were evaluated during the RI and no significant risk was identified (AFCEE 1999b).

5.12.3 Remedial Actions

The final remedy for the FS-29 plume was determined in the *Final Record of Decision for the FS-28 and FS-29 Plumes* (AFCEE 2000a) which was signed on 23 October 2000.

The RAOs for the FS-29 groundwater plume as presented in the ROD (AFCEE 2000a) and modified in the ESD (AFCEE 2011b) are as follows:

- Prevent residential exposure to FS-29 groundwater with EDB concentrations greater than the MMCL of 0.02 µg/L.
- Prevent residential exposure to FS-29 groundwater with CCl_4 concentrations greater than the MCL of 5 µg/L.
- Restore useable groundwaters to their beneficial uses wherever practicable, within a timeframe that is reasonable given the particular circumstances of the site.

5.12.3.1 Remedy Selection and Implementation

The selected remedy for FS-29 groundwater in the ROD (AFCEE 2000a) included the following components:

- The design, construction, and operation of a treatment system to hydraulically capture and treat plume contaminants,
- Institutional controls to mitigate exposure to humans from SWOU groundwater contaminants. In 1999, the Falmouth BOH adopted water well regulations to minimize the risk of exposure to groundwater contamination,
- Engineering controls to mitigate exposure to humans from SWOU groundwater contaminants. Residents potentially impacted by the plume are connected to a public water supply,
- Plume monitoring, performance monitoring of the treatment system, and ecological sampling to monitor the impacts of the system on the environment, and
- Completion of CERCLA reviews every five years throughout the lifetime of the remedial action.

Since the remedy was selected in 2000, the following changes have occurred:

1) The Wellfield Design (AFCEE 2004) presented the revised plan to treat the four Southwest Plumes (CS-4, CS-20, CS-21, and FS-29) via GAC at a centrally-located treatment plant (HATF) on the MMR.

2) The institutional controls described in the ROD were further developed as described in the Southwest Plumes ESD (AFCEE 2008b). The ESD provides a

more thorough description of the LUC Program, including a private well verification program that is being instituted for all the MMR groundwater sites.

3) The 2011 ESD for the IRP groundwater plumes (AFCEE 2011b) clarified the inclusion of MNA as a component of the selected remedy for FS-29, slightly modified the phrasing of the RAOs, and added text regarding the MMR three-step process to achieve site closure.

The FS-29 remedial system was installed in 2006 and began operation on 11 September 2006 using two extraction wells at a total flow rate of 525 gpm. The last operating FS-29 extraction well (80EW0001) was shut down in September 2010 because it was no longer contributing to cleanup of the FS-29 plume (AFCEE 2010a).

Remedial system performance monitoring data and long-term plume monitoring data collected under the SPEIM/LTM program are used to assess: (i) whether the remedial objectives are being met; (ii) whether remediation is progressing as expected; and (iii) to identify and assess optimization opportunities. The data collected under the SPEIM/LTM program are presented to the regulatory agencies through the Technical Update meeting process and documented in annual SLRs.

As part of the LUC process specified in the ROD and subsequent ESD (AFCEE 2000a, 2008b), a private well verification survey was completed for the Southwest Plumes (including FS-29) and FS-28 between April 2009 and August 2011 (AFCEE 2012e). This private well verification survey consisted of outreach to 497 parcels. Responses were obtained from 100 percent of the property owners within the LUC area and identified a total of 40 properties associated with FS-29 that have one or more private wells that are used as a non-potable water source. Technical evaluations were completed for each private well to determine the sampling frequency and/or re-evaluation frequencies (if necessary). No private wells that were identified that present an unacceptable exposure risk from FS-29 groundwater. Golf course irrigation well 69IG0018, located at TGCCC, has been monitored since 2005 and will continue to be monitored under AFCEC's LUC Program (AFCEE 2012e).

In addition, between February and July 2013, AFCEC contacted the owners of private wells that were determined to be non-operational or disconnected to confirm that these wells have not been restarted. During this 2013 outreach, AFCEC determined that 26 of the 27 private wells that were identified during the initial well verification effort as non-operational or disconnected have not been returned to service. Confirmation of the operational status of one well within the FS-29 LUC area could not be accomplished by AFCEC because the parcel is unoccupied and for sale. The status of this well and all other non-operational private wells within the FS-29 LUC area will continue to be tracked. AFCEC will distribute a mailing, on an annual basis, to property owners within the LUC area that have non-operational private wells for which no technical evaluation could be completed due to lack of known well depth and inability to sample. The intent of the annual mailing is to remind these property owners that they should contact AFCEC for a technical evaluation, which may include sampling, in the event their well is put back into service. In addition to these annual mailings, AFCEC will perform outreach as part of future Five Year Reviews to each of the property owners requiring confirmation of the non-operational status of their wells (AFCEC 2013a).

5.12.3.2 <u>Remedy Operation & Maintenance</u>

When active groundwater extraction and treatment was ongoing at FS-29, the FS-29 remedial system was operated and maintained under an approved O&M Plan (AFCEE 2012b). The O&M Plan is updated on an annual basis and includes operational requirements, a summary of the operational history of the systems, and details of any system modifications, optimizations, or improvements. While occasional operational issues are identified, these issues have been, and continue to be, addressed in a timely and effective manner such that O&M associated with the remedy is considered effective at achieving the remedy goals. Operational issues are identified in O&M monthly reports and system performance and reliability is reported in the annual SLRs.

The annual SPEIM/LTM/O&M costs associated with ongoing remedial actions at FS-29 are generally consistent with those predicted at the time of remedy selection (with consideration for savings associated with optimization initiatives) and do not indicate

potential remedy problems. The cleanup of the FS-29 groundwater plume has transitioned from active treatment to natural attenuation only, and the three-step process to achieve site closure has begun at FS-29.

5.12.4 Progress Since the Last Five Year Review

Per the EPA guidance document (EPA 2001), this section summarizes the progress made on the specific recommendations and follow-up actions presented in the prior third CERCLA Five Year Review (AFCEE 2008a). For the FS-29 groundwater plume, the recommendations and follow-up actions were:

1) Section 4.1 of the third Five Year Review recommended that a screening level VI evaluation be completed for each IRP groundwater site. The objective of the VI evaluation was to determine if a VI exposure pathway exists at a particular site, and if so, complete a screening level evaluation to determine if VI risk above target levels is likely or unlikely.

2) Section 4.3 of the third Five Year Review recommended that, in order to ensure long term protectiveness, all groundwater sites with off-base plume areas must undergo the well verification process as described in AFCEC's guideline titled *Verification, Decommissioning, and Documentation Guidelines for Private Wells in Areas of Potential Concern* (AFCEE 2008f). It was recommended that this requirement be codified in an ESD for those off-base groundwater sites with RODs that do not currently contain the well verification language as part of the required LUCs. For off-base groundwater sites without final RODs at the time of the third Five Year Review (AV and CS-10), the well verification language should be included in the LUC requirements presented in the Final RODs.

3) The RAOs in the ROD required that the Air Force "prevent or reduce residential exposure". The third Five Year Review recommended that the RAOs be modified to eliminate the word "reduce" to better ensure long-term protectiveness.

Progress since the last Five Year Review against these recommendations and follow-up actions is as follows:

1) A VI evaluation was completed for the 16 IRP groundwater sites at the MMR as documented in the *Final 2011 MMR Vapor Intrusion Evaluation Technical Memorandum* (AFCEE 2012a) including FS-29. The VI evaluation indicated an incomplete pathway for VI at FS-29 and no further monitoring or data collection is needed specific to VI at FS-29. However, as part of the ongoing remedial actions at FS-29, AFCEC will continue to monitor the nature and extent of the FS-29 plume under the SPEIM program and will re-evaluate the VI exposure pathway if conditions change such that VI could be a concern.

2) The *Final Explanation of Significant Differences for CS-4, CS-20, CS-21, FS-13, FS-28, and FS-29 Groundwater Plumes* (AFCEE 2008b) was signed on 26 September 2008 and included the requirement to complete the private well verification portion of the LUCs within three years of the signing of the ESD. This well verification effort was completed in 2011 and concluded that no private wells that were identified present an unacceptable exposure risk from the FS-29 groundwater (AFCEE 2012e). Further details of the well verification process and findings are included in Section 5.12.3.1.

3) The 2011 ESD for the IRP groundwater plumes (AFCEE 2011b) modified the phrasing of the RAOs to remove the word “reduce”. The revised RAOs are presented in Section 5.12.3.

5.12.5 Five Year Review Process

5.12.5.1 Data Review

The MMR SPEIM program was developed to monitor plume changes and to ensure the effective operation of the AFCEC groundwater remediation systems at the MMR. These objectives are met through monitoring of selected media (i.e., groundwater, surface water) within and outside the plume boundaries, treatment plant monitoring, and

groundwater flow and transport modeling. The data collected under the SPEIM program are continually assessed by a team of on-site professional staff and the results of these assessments are presented to the regulatory agencies initially during Technical Update meetings and then through technical memoranda or project note deliverables, if warranted, based on the results of the data evaluation or to address particular plume issues.

In addition, AFCEC prepares annual SLRs for the groundwater plumes that are being addressed through active treatment. The purpose of these SLRs is to document the results of sampling activities conducted at each plume under the SPEIM program. The SLRs also include: (i) a summary of all major events and optimizations completed at the plume; (ii) O&M-related system performance information such as contaminant mass removal/air emissions, system flow rate summaries, and downtime summaries; and (iii) all relevant technical assessment documentation completed during the annual reporting period as attachments or by reference. The SLRs are provided to the broad stakeholder group for each plume including Federal (EPA) and State (MassDEP, MassDPH) regulatory agencies, town departments (such as the BOHs, Departments of Public Work, Water Departments, and/or Conservation Commissions), affected property owners, and other interested parties. The SLRs are publically available in the IRP Administrative Record and copies are maintained at the local town libraries.

In addition to the annual SLRs prepared for the Southwest Plumes (including FS-29) during this Five Year Review period (AFCEC 2013b, AFCEE 2012c, 2011d, 2010c, 2009c, 2008g), the following technical deliverables were prepared that assessed system performance or presented the results of optimization evaluations:

- *Final CS-4, CS-20, CS-21 and FS-29 Baseline SPEIM Report* (AFCEE 2008e)
- *Southwest Plumes 2008 Annual SPEIM Data Presentation Project Note* (AFCEE 2008c)
- *Southwest Plumes 2009 Triennial SPEIM Data Presentation Project Note* (AFCEE 2009b)
- *FS-29 80EW0002 Optimization Summary Project Note* (AFCEE 2009a)

- *Southwest Plumes 2010 Annual SPEIM Data Presentation Project Note* (AFCEE 2010b)
- *FS-29 Extraction Well 80EW0001 Interim Shut Down Project Note* (AFCEE 2010a)
- *Southwest Plumes 2010 Semiannual SPEIM Data Presentation Project Note* (AFCEE 2011c)
- *Southwest Plumes 2011 Annual SPEIM Data Presentation Project Note* (AFCEE 2011a)
- *Southwest Plumes 2011 Semiannual SPEIM Data Presentation Project Note* (AFCEE 2012d)
- *Southwest Plumes 2012 Triennial SPEIM Data Presentation Project Note* (AFCEC 2012)

While additional details are provided in the documents listed above, the primary findings and conclusions from these system performance evaluations at FS-29 are as follows:

1. The FS-29 remedial system removed approximately 4 lbs of COCs through the treatment of approximately 374 million gallons of groundwater during this Five Year Review period. The FS-29 remedial system treated approximately 722 million gallons of contaminated groundwater and removed approximately 9 lbs of COCs between system startup (September 2006) and system shutdown (September 2010).

2. A comparison of the FS-29 plume boundary at the start and end of this Five Year Review period (i.e., 2007 versus 2012) is included on **Figure 5-12B**. COC concentration trends at select groundwater monitoring wells are shown in **Figure 5-12C**. The highest EDB detection in the FS-29 plume between 2007 and 2012 was 0.084 µg/L collected from monitoring well 80MW0001B in May 2009. The five highest EDB detections at FS-29 in 2007 ranged from 0.017 to 0.042 µg/L. In 2012, the five highest EDB detections at FS-29 ranged from below the reporting limit to 0.015 µg/L (**Figure 5-12C**).

3. Through a combination of active treatment and natural attenuation, the plume remediation has progressed faster than expected. A review of the SPEIM data indicates that the plume extent and concentrations are declining faster than expected (only sporadic detections of COCs remain in the FS-29 monitoring network). The FS-29 remedial system was successful in capturing and containing the FS-29 plume, and was shut down in September 2010 because it was no longer contributing to the cleanup of the FS-29 plume (i.e., no EDB was detected in the extraction well influent and CCl_4 concentrations were low). It appears that the restoration timeframe predicted by groundwater modeling at the time of remedy selection (i.e., COC concentrations decline to less than their respective groundwater standards by approximately 2014) will be met.

4. The FS-29 COCs (EDB and CCl_4) have never been detected in samples collected from TGCCC irrigation well 69IG0018.

5. Plume monitoring under AFCEC's SPEIM/LTM program should continue at FS-29 to provide the necessary data to manage potential exposure risks, evaluate optimization opportunities, and begin the three-step process to achieve site closure at FS-29 (AFCEE 2011b).

5.12.5.2 Site Inspections

Refer to Section 3.5.

5.12.5.3 Interviews

Refer to Section 3.6.

5.12.6 Technical Assessment

The technical assessment component of the Five Year Review consists of evaluating the protectiveness of the remedy. The technical assessment is based on EPA guidance provided in Section 4.0 of the Comprehensive Five Year Review Guidance (EPA 2001).

5.12.6.1 Question A: Is the remedy functioning as intended by the decision documents?

Yes, the completion of the ROD in 2000, construction and startup of the remedial system in 2006, and completion of the well verification/well determination portion of the LUCs in 2011 have resulted in the remedy at FS-29 functioning as intended by the decision documents. The remedial system performed as expected. Through the combination of the treatment by the remedial system (between system startup in 2006 and shutdown in 2010) and natural attenuation processes, groundwater cleanup levels are expected to be achieved within the timeframe approximated in the ROD (i.e., 2014). Operational costs are appropriate for the remedy and a robust optimization program continues with the objective of reducing remedial system operational timeframes, the time to reach remedial goals (e.g., MCLs), and reducing future costs. Monitoring and evaluation activities are continual and well-documented.

5.12.6.2 Question B: Are the exposure assumptions, toxicity data, cleanup levels, and remedial action objectives (RAOs) used at the time of the remedy selection still valid?

Changes in Standards and To-Be Considered: There have been no changes in standards or TBC guidance.

Changes in Exposure Pathways: There have been no changes to exposure pathways or land use of the site that would affect the protectiveness of the remedy. Since the VI exposure pathway was not considered in the RI, a more thorough evaluation has been completed and the VI pathway was found to be incomplete (AFCEE 2012a).

Changes in Toxicity and Other Contaminant Characteristics: There have been no changes in the toxicity factors or other contaminant characteristics for the FS-29 groundwater COC EDB during this Five Year Review period and the MMCL remains at 0.02 µg/L. However, the toxicity factors that were in place at the time of the last Five Year Review (i.e., 2007) for CCl_4 have been updated.

The carcinogenic toxicity values (oral and inhalation) and oral non-cancer toxicity values for CCl_4 became less conservative, while the inhalation non-cancer toxicity value became more conservative but by less than an order of magnitude (EPA 2013). These toxicity changes for CCl_4 did not lead to a change in the MCL of 5 μg/L.

Since the RAOs and risk management decisions associated with FS-29 groundwater are based on MMCLs and MCLs, the changes in toxicity values do not affect the protectiveness of the remedy. However, these updated toxicity values (or values derived from future updates) should be used when performing the residual risk assessment as part of the three-step process to achieve site closure (AFCEE 2011b).

<u>Changes in Risk Assessment Methods</u>: There were no changes in risk assessment methodology.

<u>Review of RAOs</u>: The RAOs developed for the final ROD (AFCEE 2000a) and revised in the 2011 ESD (AFCEE 2011b) are appropriate and remain valid.

5.12.6.3 <u>Question C: Has any other information come to light that could call into question the protectiveness of the remedy?</u>

No.

5.12.7 Issues, Recommendations, and Follow-Up Actions

No specific recommendation or follow-up actions have been identified. However, the topic of emerging contaminants should be monitored as it relates to groundwater at FS-29 and the MMR.

5.12.8 Protectiveness Statement

The remedy for the FS-29 groundwater plume is protective of human health and the environment. The remedial system performed for a shorter time than expected. The LUCs are in place and are functioning as intended. Now that active treatment is no longer needed, groundwater cleanup levels are expected to be achieved through natural

attenuation processes within the timeframe approximated in the ROD, which was considered reasonable given the particular circumstances of the site.

5.12.9 References

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5.13 LANDFILL-1 (LF-1) GROUNDWATER

The LF-1 plume is a dissolved-phase groundwater plume (**Figure 5-13A**) that contains the following eight COCs: PCE, TCE, vinyl chloride (VC), CCl_4, 1,4-dichlorobenzene (1,4-DCB), 1,1,2,2-TeCA, EDB and Mn. The LF-1 plume boundary is defined as the extent of groundwater containing PCE and TCE at concentrations exceeding their MCL of 5 µg/L. The current distribution of the remaining six LF-1 COCs at concentrations exceeding their respective standards is contained within the area of the composite TCE/PCE plume boundary (**Figure 5-13A**). The cleanup levels for the remaining six LF-1 COCs are as follows: VC (MCL = 2 µg/L); CCl_4 (MCL = 5 µg/L); 1,4-DCB (MMCL = 5 µg/L); 1,1,2,2-TeCA (MCP GW-1 standard = 2 µg/L); EDB (MMCL = 0.02 µg/L); and Mn (EPA HA = 300 µg/L).

5.13.1 Site Chronology

1983: A records search identified the MMR landfill as a potential source for the VOCs detected in June 1979 in a base water supply well (the G well) approximately 6,000 ft downgradient of the landfill (ANG 1983).

1985 - 1996: Numerous other investigations (ABB-ES 1992; ANG 1985 and 1991; and E.C. Jordan 1988, 1990a, 1990b) were conducted which culminated in an RI report (AFCEE 1996b).

1994 - 1995: The NGB, DOD, EPA, MassDEP, and local communities approved a Plume Response Plan that presented an accelerated effort toward “simultaneous containment” of seven groundwater plumes including LF-1. An IROD for the seven groundwater plumes emanating from the MMR was signed on 25 September 1995 (ANG 1995). The IROD stated that groundwater extraction and treatment systems should be designed, installed, and operated until a final remedy for the site is chosen. The interim remedy for the LF-1 plume included extraction of contaminated groundwater and discharge of treated water to groundwater (and/or other beneficial use) and institutional controls.

1999: Completion of the wellfield design which consisted of five extraction wells and an infiltration gallery (AFCEE 1999) that began operation on 26 August 1999 (AFCEE 2002).

2006: The feasibility study was completed (AFCEE 2006c) followed by the release of the proposed plan (AFCEE 2006b).

2006: As part of the final remedy, AFCEE expanded the remedial system by adding an extraction well (27EW0006) to meet the design objective of capturing the plume at the base boundary (AFCEE 2006a, 2007).

2007: ROD finalized (AFCEE 2007).

2011: An ESD was prepared that clarified the inclusion of MNA as a component of the selected remedy, slightly modified the phrasing of the RAOs, and added text regarding the MMR three-step process to achieve site closure (AFCEE 2011b).

5.13.2 Background

5.13.2.1 History of Contamination

The LF-1 source area is a solid waste landfill located in the southern portion of the MMR and is bounded by Turpentine Road to the east, Frank Perkins Road to the west, Herbert Road to the north, and Connery Avenue to the south (**Figure 5-13A**). The LF-1 source area, which occupies approximately 100 acres of open to heavily wooded terrain, began operating in 1941 as the primary solid waste disposal facility at MMR. From the late 1940s until 1984, unregulated disposal activities were conducted at the site; from 1984 to 1993, regulated disposal activities were conducted by the NGB at the LF-1 landfill as a component of the MMR Hazardous Waste Management Plan. Disposal at the landfill occurred in six areas consisting of five distinct cells and a natural kettle hole. The cells are designated by the years representing the approximate end date of waste disposal activities. The six disposal areas include the 1947, 1951, and 1957 cells, referred to as the NWOU, which occupy approximately 40 acres of the total LF-1 landfill area; and the

1970 and Post-1970 cells and the Kettle Hole, which occupy approximately 50 acres. The remaining 10 acres comprise the space between and surrounding the cells. The thickness of waste burial has not been accurately determined, but is estimated to be about 20 ft thick for the 1970 and Post-1970 cells; while the thickness of waste in the Kettle Hole is unknown (E.C. Jordan Co. 1988 and 1990b). Approximately 100 additional acres were used in and around the site for construction soil material borrow pits, access roads, staging areas, and cross gradient or downgradient surface water recharge areas (i.e., retention/detention basins).

Accurate documentation of the wastes disposed of at the LF-1 landfill does not exist. The wastes are believed to include general refuse, fuel tank sludge, herbicides, solvents, transformer oils, fire extinguisher fluids, blank small arms ammunition, paints, paint thinners, batteries, DDT powder, hospital wastes, municipal sewage sludge, coal ash, and possibly live ordnance (AFCEE 2012c).

5.13.2.2 Physical Characteristics, Land and Resource Use

Based on the most recent groundwater monitoring data collected in 2012, the LF-1 plume is approximately 3.5 miles long, and extends from the landfill source area (in the northeast) to the west-southwest where the uncaptured portions of the northern and southern lobes of the plume discharge with groundwater to Red Brook Harbor and Squeteague Harbor, respectively (**Figure 5-13A**). The LF-1 plume has a maximum width of approximately 4,500 ft and a maximum vertical thickness in the aquifer of approximately 110 ft. The footprint of the LF-1 plume was approximately 1,124 acres in 2007, and was approximately 919 acres in 2012 (**Figure 5-13B**).

The area above the on-base portions of the LF-1 plume consists primarily of a housing area operated by the USCG and a cemetery operated by the U.S. Department of Veterans Affairs. The land use above the plume in the off-base area between the MMR base boundary and Route 28 is characterized by undeveloped woodlands (**Figure 5-13A**). The off-base area west of Route 28 is primarily residential, with smaller areas characterized as recreational, conservation land, and limited industrial/commercial. The topography of

the land at the far eastern and western portions of the LF-1 plume can be characterized as broad, flat, gently sloping glacial outwash plains. However, in the middle of the LF-1 plume area centering on the extraction well fence, the plume travels through and beneath a hummocky north-south trending ridge of moraine glacial deposits. Within the footprint of the plume, the maximum and minimum ground surface elevations are 259 ft msl and 0 ft msl, respectively.

The Town of Bourne operates two PWSWs (BOPWS0002 and BOPWS0005) that are located approximately 2,500 ft downgradient (i.e., west) of the base boundary and the LF-1 infiltration system (**Figure 5-13A**). The LF-1 remedial design (AFCEE 1999) included an infiltration system (later supplemented with a reinjection well) positioned upgradient of the PWSWs in order to deflect the plume away from the PWSWs and flood the zones of contribution of the water supply wells with treated water. Five sentry monitoring wells located between the PWSWs and the LF-1 infiltration system/reinjection well are monitored on an annual basis to determine whether the LF-1 plume COCs are present in groundwater upgradient of the water supply wells. The analytical results are provided to the Bourne Water District and the regulatory agencies in annual letter reports.

5.13.2.3 Initial Responses

A summary of the initial responses is as follows:

Non-CERCLA Actions

None.

CERCLA Actions

LF-1 Source Area Remedial Actions: A PRA for the landfill indicated that through residential exposure to source area groundwater there was risk that exceeded the EPA and MassDEP criteria for cancer and non-cancer target risk levels. Based on the results of the risk assessment, a feasibility study for the LF-1 landfill identified a number of potential

remedial alternatives to reduce contaminants leaching to the groundwater (ABB-ES 1992). An interim remedy was selected that was designed to protect human health and the environment and comply with ARARs. The interim remedial action for the landfill (ANG 1993b) consisted of the following actions:

1. Leaving NWOU wastes in place beneath the soil and vegetative cover and installing downgradient monitoring wells to assess any impacts to groundwater from the older cells and to determine if the interim remedial action is an appropriate long-term remedial action. Monitoring wells were selected for sampling on a regular basis.

2. Construction of a landfill cover system (consisting of an impermeable cap) on the 1970 and Post-1970 cells and the Kettle Hole.

3. Preparation of a PCM Plan for the 1970 cell, the Post-1970 cell, and the Kettle Hole.

Closure activities at the LF-1 landfill, including capping the three most recently used cells (since they were the apparent sources of groundwater contamination) and instituting PCM, were completed in December 1995. In addition to the caps, the LF-1 landfill cover system includes an associated drainage system, and 70 gas vents designed to release gas from the interior of the landfill. Gas probes are located around the perimeter of the caps to monitor subsurface vapor. A perimeter fence already existed around the entire landfill (capped cells and NWOU) at the time of capping. Further details of the closure activities are provided in *Closure Plan for Study Area LF-1 1970 Cell, Post-1970 Cell, and Kettle Hole Technical Specifications (90 Percent Design)* (ANG 1992). The primary purpose of the landfill cover and associated drainage structures is to minimize the amount of precipitation that infiltrates the landfill and produces leachate (water containing contaminants, nutrients, and microorganisms) that could reach the aquifer.

The PCM Plan for LF-1 landfill outlined the following actions (ANG 1993a):

1. Post-closure maintenance and monitoring of the cover system is to be conducted for a minimum of 30 years after the completion of cap construction. To verify that the cap maintains its structural integrity, it is inspected for animal burrows, erosion rills, settlement depressions, intrusive vegetation, seeps, and sedimentation in ditches and culverts. Post-closure maintenance is performed any time a loss of integrity is noticed; landfill inspections and land surveys are performed regularly.

2. Landfill gas and groundwater quality at the landfill are to be monitored as appropriate. The landfill interim remedial action will allow time to further evaluate the environmental impact of the 1947, 1951, and 1957 cells (i.e., the NWOU cells) on groundwater quality.

3. A regular performance monitoring evaluation of the interim remedial action.

In 1996, the EPA and MassDEP approved the closure report for the LF-1 capped cells (AFCEE 1996a), thus initiating the LTM program actions listed above, and as described in the *Final LF-1 2011 Post-Closure Monitoring Plan Update* (AFCEE 2012c).

<u>LF-1 Groundwater Plume</u>: The DoD and EPA, with concurrence from the MassDEP, implemented an interim action for the LF-1 groundwater plume and six other MMR plumes under an IROD (ANG 1995). The selected remedy for the LF-1 plume included extraction of contaminated groundwater and discharge of treated water to groundwater (and/or other beneficial use) and institutional controls.

The TRET, established in 1996 as part of a new IROD management process, reviewed wellfield designs and determined that the 60-percent design for containment of several of the IROD plumes would cause negative ecological impacts (TRET 1996). The proposed interim remedy for the LF-1 groundwater plume was then revised to include the design and installation of an ETI remedial system to capture the LF-1 Northern and Southern lobes at the MMR base boundary with MNA for the on-base Central lobe (AFCEE 1998).

Downgradient (i.e., west) of the MMR base boundary, the LF-1 plume was expected to naturally attenuate and/or discharge to Red Brook or Squeteague harbors. In addition, as part of the interim remedy, the Air Force agreed to complete a study to estimate the extent of natural resources damage; to work with the Natural Resources Trustees and regulators to develop the scope, schedule, oversight and review of this natural resources study; to provide funding to replace Bourne PWSWs BOPWS0002 and BOPWS0005 (referred to as the Bourne Water Provision); and to connect residents using private wells within the footprint or path of the plume to municipal water supplies.

The interim LF-1 remedial system began operation on 26 August 1999 with five extraction wells at a design extraction rate of 700 gpm with treatment through GAC. Extracted groundwater is treated by GAC at the LF-1 treatment plant and is returned to the aquifer through a reinjection well (added in 2008), infiltration gallery and two infiltration trenches.

Data collected after the interim LF-1 remedial system began operation indicated that a previously uncharacterized portion of the LF-1 plume would escape capture of the system and migrate off-base to such a degree as to not meet the system design goals (restoring the aquifer between the MMR western base boundary and Route 28 within 20 years of remedial system start-up) (AFCEE 2005). As part of the final remedy AFCEE expanded the remedial system by adding an extraction well (27EW0006) along the southern plume boundary to meet the design objective of capturing the plume at the base boundary (AFCEE 2007). Extraction well 27EW0006 was installed concurrently with CS-23 extraction wells 27EW0007 and 27EW0008 (AFCEE 2006a); all three extraction wells began operation on 05 December 2006. The extracted groundwater from the extraction wells in the southern portion of LF-1 (27EW0002 and 27EW0006) is combined with the extracted groundwater from 27EW0007 and 27EW0008, treated at the HATF by GAC, and is then returned to the aquifer through two infiltration trenches. The HATF was constructed as part of the remedial action for the CS-4, CS-20, CS-21, and FS-29 plumes (AFCEE 2008b). Further details regarding the LF-1/CS-23 HATF remedial system can be found in the 2012 O&M Plan (AFCEE 2012d).

An ESD for the IRP groundwater plumes was submitted in September 2011 that clarified the inclusion of MNA as a component of the selected remedy, slightly modified the phrasing of the RAOs, and updated the steps to achieve site closure (i.e., the three-step process) (AFCEE 2011b).

5.13.2.4 Basis for Taking Action

The baseline cancer risk calculations in the LF-1 RI indicated that unless remedial action is undertaken, future residential exposure to the LF-1 COCs in groundwater may present an excess lifetime cancer risk greater than the acceptable MassDEP threshold of $1x10^{-5}$ and the acceptable EPA range of $1x10^{-4}$ to $1x10^{-6}$ (AFCEE 1996b). Ecological risks associated with the LF-1 groundwater plume (AFCEE 1996b) as well as evaluations of contaminant body burdens in shellfish and sediment pore water (TRET 2001; ATSDR 2002) have indicated no significant risk was identified (AFCEE 2004). It is noted that ecological monitoring continues in order to assess hydraulic effects to a nearby wetland and vernal pool due to the operation of the expanded remedial system (refer to Sections 5.13.4 and 5.13.5).

5.13.3 Remedial Actions

The final remedy for the LF-1 plume was determined in the *Final Record of Decision for the LF-1 Source Area and Groundwater* (AFCEE 2007) which was signed on 28 September 2007.

The RAOs for the LF-1 groundwater plume as presented in the ROD (AFCEE 2007) and modified in the ESD (AFCEE 2011b) are as follows:

- Prevent residential exposure to LF-1 groundwater with TCE concentrations greater than the MCL of 5 µg/L.
- Prevent residential exposure to LF-1 groundwater with PCE concentrations greater than the MCL of 5 µg/L.
- Prevent residential exposure to LF-1 groundwater with CCl_4 concentrations greater than the MCL of 5 µg/L.

- Prevent residential exposure to LF-1 groundwater with 1,1,2,2-TeCA concentrations greater than the Massachusetts GW-1 standard of 2 µg/L.
- Prevent residential exposure to LF-1 groundwater with VC concentrations greater than the MCL of 2 µg/L.
- Prevent residential exposure to LF-1 groundwater with EDB concentrations greater than the MMCL of 0.02 µg/L.
- Prevent residential exposure to LF-1 groundwater with 1,4-DCB concentrations greater than the MMCL of 5 µg/L.
- Prevent residential exposure to LF-1 groundwater with Mn concentrations greater than the HA of 300 µg/L.
- Restore useable groundwaters to their beneficial uses wherever practicable, within a timeframe that is reasonable given the particular circumstances of the site.
- Prevent exposure to LF-1 groundwater for human receptors under non-residential use scenarios (including dermal contact, ingestion, and inhalation), unless shown that such use does not present a carcinogenic risk in excess of the EPA target risk range of 10^{-4} to 10^{-6} or present a non-carcinogenic hazard index greater than 1.0.

5.13.3.1 Remedy Selection and Implementation

The selected remedy for the LF-1 groundwater operable unit in the ROD (AFCEE 2007) included the following components:

- Continued operation of the existing LF-1 ETI system (five extraction wells and an associated infiltration gallery), the installation of one additional extraction well (27EW0006) south of 27EW0002 to increase capture of the southern portion of the LF-1 plume, and the Bourne Water Provision (Note: the LF-1 infiltration gallery and trenches have since been supplemented with a reinjection well).
- Implementation of LUCs for the LF-1 groundwater selected remedy with the performance objectives of:
    - Prevent or reduce access to or use of the groundwater from the LF-1 contaminated groundwater until the groundwater no longer poses an unacceptable risk, and
    - Maintain the integrity of the current or future remedial or monitoring system such as the landfill cover system, the treatment systems, and monitoring wells.
- Chemical and hydraulic monitoring of the plume, as long as active remediation continues, and chemical monitoring of the plume until the RAOs are met.
- Completion of CERCLA reviews every five years throughout the lifetime of the remedial action.

Since the groundwater remedy was selected in 2007, the following changes have occurred: the 2011 ESD for the IRP groundwater plumes (AFCEE 2011b) clarified the inclusion of MNA as a component of the selected remedy for LF-1, slightly modified the phrasing of the RAOs, and added text regarding the MMR three-step process to achieve site closure.

Remedial system performance monitoring data and long-term plume monitoring data collected under the SPEIM program are used to: i) assess whether the remedial objectives and system performance metrics are being met; ii) assess whether remediation is progressing as expected, and; iii) identify and assess optimization opportunities. The data collected under the SPEIM program are presented to the regulatory agencies through the Technical Update meeting process and documented in annual SLRs.

The close proximity of the LF-1 and CS-23 plumes and remedial systems warrant that the LF-1 and CS-23 SPEIM programs be combined. Therefore, data collection, data assessment, groundwater modeling, and reporting are performed jointly under a combined LF-1/CS-23 SPEIM program.

As part of the LUC process specified in the ROD (AFCEE 2007), a private well verification survey was completed for the LF-1 and CS-23 plumes between November 2008 and August 2010. This private well verification survey consisted of outreach to 482 parcels. Responses were obtained from 100 percent of the property owners within the LUC area and identified a total of 68 properties within the LF-1 LUC area that have one or more actively used private wells. Two of the wells identified are used to supply drinking water whereas the remainder as used for outdoor purposes. Technical evaluations were completed for each private well to determine the sampling frequency and/or re-evaluation frequencies (if necessary) (AFCEE 2011d). No private wells that were identified present an unacceptable exposure risk from the LF-1 groundwater. Due to its location near a plume discharge area (Squeteague Harbor), one private well was selected to be sampled annually as part of AFCEC's LUC Program. In the event that new private well information is obtained or plume monitoring data indicate a change to the

CSM at LF-1, AFCEC will perform the necessary well determinations at the time the information becomes available.

In addition, by September 2012, AFCEC confirmed that 52 private wells that were identified during the initial well verification effort but were non-operational or disconnected have not been returned to service (AFCEC 2013b). AFCEC could not contact the owners of two properties with non-operational wells because they were unoccupied (one property was for sale).

The status of non-operational private wells within the LF-1 LUC area will continue to be tracked. AFCEC will distribute a mailing, on an annual basis, to property owners within the LUC area that have non-operational wells for which no technical evaluation could be completed due to lack of known well depth and inability to sample. The intent of the annual mailing is to remind these property owners that they should contact AFCEC for a technical evaluation, which may include sampling, in the event their well is put back into service. In addition to these annual mailings, AFCEC will perform outreach as part of future Five Year Reviews to each of the property owners requiring confirmation of the non-operational status of their wells (AFCEC 2013b).

5.13.3.2 Remedy Operation & Maintenance

The LF-1 remedial system is operated and maintained under an approved O&M Plan (AFCEE 2012d). The O&M Plan is updated on an annual basis and includes operational requirements, a summary of the operational history of the systems, and details of any system modifications, optimizations, or improvements. While occasional operational issues are identified, these issues have been, and continue to be, addressed in a timely and effective manner such that O&M associated with the remedy is considered effective at achieving the remedy goals. Operational issues are identified in O&M monthly reports and system performance and reliability is reported in the annual SLRs.

The annual SPEIM/LTM/O&M costs associated with ongoing remedial actions at LF-1 are generally consistent with those predicted at the time of remedy selection (with consideration for savings associated with optimization initiatives) and do not indicate potential remedy problems.

5.13.4 Progress Since the Last Five Year Review

Per the EPA guidance document (EPA 2001), this section summarizes the progress made on the specific recommendations and follow-up actions presented in the prior third CERCLA Five Year Review (AFCEE 2008a). For the LF-1 groundwater plume, the recommendations and follow-up actions were:

1) Section 4.1 of the third Five Year Review recommended that a screening level VI evaluation be completed for each IRP groundwater site. The objective of the VI evaluation was to determine if a VI exposure pathway exists at a particular site, and if so, complete a screening level evaluation to determine if VI risk above target levels is likely or unlikely.

2) Section 4.3 of the third Five Year Review recommended that, in order to ensure long term protectiveness, all groundwater sites with off-base plume areas must undergo the well verification process as described in AFCEC's guideline titled *Verification, Decommissioning, and Documentation Guidelines for Private Wells in Areas of Potential Concern* (AFCEE 2008d). It was recommended that this requirement be codified in an ESD for those off-base groundwater sites with RODs that do not currently contain the well verification language as part of the required LUCs. For off-base groundwater sites without final RODs at the time of the third Five Year Review (AV and CS-10), the well verification language should be included in the LUC requirements presented in the Final RODs.

3) The third Five Year Review recommended continuing to monitor the wetland and vernal pool near LF-1/CS-23 for potential ecological impacts associated with the surface water drawdown.

Progress since the last Five Year Review against these recommendations and follow-up actions is as follows:

1) A VI evaluation was completed for the 16 IRP groundwater sites at the MMR as documented in the *Final 2011 MMR Vapor Intrusion Evaluation Technical Memorandum* (AFCEE 2012a) including LF-1. The VI evaluation indicated an incomplete pathway for VI at LF-1 and no further monitoring or data collection is needed specific to VI at LF-1. However, as part of the ongoing remedial actions at LF-1, AFCEC will continue to monitor the nature and extent of the LF-1 plume under the SPEIM program and will re-evaluate the VI exposure pathway if conditions change such that VI could be a concern.

2) The final remedy for LF-1 plume was determined in the *Final Record of Decision for the LF-1 Source Area and Groundwater* (AFCEE 2007) which was signed on 28 September 2007 and included the requirement to complete the private well verification portion of the LUCs within three years of the signing of the ROD. This well verification effort was completed in 2010 and concluded that no private wells that were identified present an unacceptable exposure risk from the LF-1 groundwater (AFCEE 2011d). Further details of the well verification process and findings are included in Section 5.13.3.1.

3) The results of ecological and hydrologic monitoring at the LF-1/CS-23 vernal pools and wetlands indicate that while the water levels have lowered (possibly due to the operation of the system), the ecosystems, vegetation, and wildlife habitats have not changed significantly between 2007 and 2012 (AFCEE 2012b, 2011a, 2011e, 2010c, 2009b).

5.13.5 Five Year Review Process

5.13.5.1 Data Review

The MMR SPEIM program was developed to monitor plume changes and to ensure the effective operation of the AFCEC groundwater remediation systems at the MMR. These objectives are met through monitoring of selected media (i.e., groundwater, surface

water) within and outside the plume boundaries, treatment plant monitoring, and groundwater flow and transport modeling. The data collected under the SPEIM program are continually assessed by a team of on-site professional staff and the results of these assessments are presented to the regulatory agencies initially during Technical Update meetings and then through technical memoranda or project note deliverables, if warranted, based on the results of the data evaluation or to address particular plume issues.

In addition, AFCEC prepares annual SLRs for the groundwater plumes that are being addressed through active treatment. The purpose of these SLRs is to document the results of sampling activities conducted at each plume under the SPEIM program. The SLRs also include: (i) a summary of all major events and optimizations completed at the plume; (ii) O&M-related system performance information such as contaminant mass removal/air emissions, system flow rate summaries, and downtime summaries; and (iii) all relevant technical assessment documentation completed during the annual reporting period as attachments or by reference. The SLRs are provided to the broad stakeholder group for each plume including Federal (EPA) and State (MassDEP, MassDPH) regulatory agencies, town departments (such as the BOHs, Departments of Public Work, Water Departments, and/or Conservation Commissions), affected property owners, and other interested parties. The SLRs are publically available in the IRP Administrative Record and copies are maintained at the local town libraries.

In addition to the annual SLRs prepared for LF-1 during this Five Year Review period (AFCEC 2013c; AFCEE 2012e, 2011c, 2010b, 2009c, 2008e), the following technical deliverables were prepared that assessed system performance, the potential hydrologic and ecological impacts of system operation, and presented the results of optimization evaluations:

- *LF-1/CS-23 2008 Annual SPEIM Data Presentation Project Note* (AFCEE 2008c)
- *LF-1/CS-23 2008 Wetland and Surface Water Ecological Evaluation* (Attachment D of AFCEE 2009c)

- *Final LF-1/CS-23 2007 Plume Update Technical Memorandum* (AFCEE 2009b)
- *LF-1/CS-23 2009 Annual SPEIM Data Presentation Project Note* (AFCEE 2009a)
- *LF-1/CS-23 2009 Wetland and Surface Water Ecological Evaluation Project Note* (AFCEE 2010c)
- *LF-1/CS-23 2010 Annual SPEIM Data Presentation Project Note* (AFCEE 2010a)
- *LF-1/CS-23 2010 Wetland and Surface Water Ecological Evaluation Project Note* (AFCEE 2011e)
- *LF-1/CS-23 2011 Wetland and Surface Water Ecological Evaluation Project Note* (AFCEE 2011a)
- *LF-1/CS-23 2011 Triennial SPEIM Data Presentation Project Note* (AFCEE 2012f)
- *LF-1/CS-23 2012 Wetland and Surface Water Ecological Evaluation Project Note* (AFCEE 2012b)
- *LF-1/CS-23 2012 Annual SPEIM Data Presentation Project Note* (AFCEC 2013d)
- *LF-1 Source Area Direct Push Sample Results and Continuing Source Evaluation Project Note* (AFCEC 2013a)

While additional details are provided in the documents listed above, the primary findings and conclusions from these system performance evaluations at LF-1 are as follows:

1. The LF-1 extraction wells removed approximately 256 lbs of COCs through the treatment of approximately 2.9 billion gallons of groundwater during this Five Year Review period. In total, between system startups (in August 1999 for 27EW0001 – 27EW0005 and December 2006 for 27EW0006) and December 2012, the LF-1 extraction wells have removed approximately 598 lbs of COCs through the treatment of approximately 6 billion gallons of groundwater.

2. A comparison of the LF-1 plume boundary at the start and end of this Five Year Review period (i.e., 2007 vs. 2012) is included on **Figure 5-13B**. COC concentration trends at select groundwater monitoring wells are shown in **Figures 5-13C**, **5-13D**, **5-13E**, **5-13F**, and **5-13G**. The highest COC detection in

the LF-1 plume between 2007 and 2012 was for TCE at 88 µg/L collected from monitoring well 27MW2135A in June 2012. The five highest COC detections at LF-1 in 2007 were for both PCE and TCE and ranged from 26.9 to 50.5 µg/L. In 2012, the five highest COC detections at LF-1 were for both PCE and TCE and ranged from 21 to 88 µg/L (**Figure 5-13F**).

3. Overall, a review of monitoring data collected under the SPEIM program indicates that remediation is progressing as expected. However, COC concentrations in the off-base portion of the plume are declining faster than predicted by the contaminant transport modeling completed at LF-1. In contrast, the overall model-predicted aquifer restoration timeframe estimated from the most recent transport modeling (AFCEC 2013c) is longer than predicted at the time of the ROD (see modeling discussion in the following bullet).

4. A remedial system optimization assessment completed between 2009 and 2011 using the Parameter Estimation (PEST) modeling approach suggested that flow rates could be reduced at the LF-1 remedial system while meeting the remedial goals of the system (AFCEC 2013c). However, EPA raised concerns about the modeled restoration timeframe (i.e., approximate year in which PCE and TCE concentrations declined below the MCL) predicted using the PEST modeling approach versus the restoration timeframe presented in the ROD. AFCEE presented monitoring data during Technical Update meetings which indicated that the PEST modeling predictions using the 2007 version of the plume shell over-predicted both plume extent and contaminant concentrations in the short-term (i.e., the five years between 2007 and 2012). This effect was likely compounded in the longer-term modeling results (greater than 20 years out), which would result in an overestimation of the restoration timeframes predicted by the PEST modeling. Due to EPA's concerns, AFCEE rescinded the proposal to implement the PEST-optimized flow rates for the LF-1/CS-23 remedial system. As a next step, AFCEC and the regulatory agencies agreed that a comprehensive sampling event would be performed at LF-1/CS-23 in 2013. These data will be used to update the LF-1/CS-23 plume shell and assess the performance of the remedial

system in a modeling based optimization evaluation. A goal of this optimization evaluation will be to update the estimated timeframe to reach aquifer restoration so a comparison to the timeframes predicted in the ROD can be made.

5. A discrepancy related to the way in which the restoration timeframe is determined based on the transport modeling results should be addressed during the planned optimization evaluation. The transport simulation presented in the ROD indicated that PCE concentrations would remain above the MCL beyond model simulation year 2058 (which was the last year of the modeling simulation). However, the ROD cited uncertainty in the delineation of the extent of PCE in the aquifer where PCE concentrations remained in the transport simulation, and given the immobility of PCE in a suspected low hydraulic conductivity unit in that area, stated that the PCE restoration timeframe was very uncertain. Therefore, the predicted aquifer restoration timeframe presented in the LF-1 ROD was approximately 2045 and was based on the results of the TCE transport simulation (i.e., when TCE concentrations declined below the MCL). In contrast, the PEST-optimized restoration timeframe date of approximately 2060 was based on a simulation that considered the fate of both the PCE and TCE plumes at LF-1. The estimated aquifer restoration timeframe using the PEST-modeling technique (which considered both PCE and TCE) is 15 years longer than the timeframe estimated in the ROD (i.e., 2060 vs. 2045), but the ROD only considered TCE.

6. Detectable concentrations of PCE and TCE continue to be reported in Red Brook Harbor and Squeteague Harbor surface water providing evidence that the LF-1 plume is discharging to the harbors (**Figure 5-13A**). PCE and TCE concentrations in surface water were typically less than 1 µg/L, but ranged up to 2.6 µg/L in May 2009 (AFCEE 2010b). These surface water detections are well below MCLs and the MassDEP Ambient Water Quality Criteria Standards of 1,100 µg/L (PCE) and 190 µg/L (TCE) and do not represent a human health or ecological exposure risk (AFCEE 2008e, 2009c, 2010b, 2011c, 2012e).

7. The results of ecological and hydrologic monitoring at the LF-1/CS-23 vernal pools and wetlands indicate that while the water levels have lowered (possibly due to the operation of the system), the ecosystems, vegetation, and wildlife habitats have not changed significantly between 2007 and 2012.

8. The results of a direct push drilling program completed near the landfill, and historical groundwater monitoring review for monitoring wells located within and just hydraulically downgradient of the landfill indicate that the landfill is not a continuing source for the LF-1 groundwater plume.

9. Monitoring results from the NWOU continue to provide evidence that the uncapped NWOU cells are not a source of groundwater contamination (i.e., no MCL exceedances have ever been detected).

10. Plume monitoring under AFCEC's SPEIM/LTM program should continue at LF-1 to provide the necessary data to manage potential exposure risks, assess remedial progress, and evaluate optimization opportunities.

5.13.5.2 Site Inspections

Refer to Section 3.5.

5.13.5.3 Interviews

Refer to Section 3.6.

5.13.6 Technical Assessment

The technical assessment component of the Five Year Review consists of evaluating the protectiveness of the remedy. The technical assessment is based on EPA guidance provided in Section 4.0 of the Comprehensive Five Year Review Guidance (EPA 2001).

5.13.6.1 Question A: Is the remedy functioning as intended by the decision documents?

Yes, the completion of the ROD in 2007, construction and startup of the remedial system in 1999, remedial system expansion and startup in 2006, continued operation of the remedial system, and completion of the well verification/well determination portion of the LUCs in 2011 have resulted in the remedy at LF-1 functioning as intended by the decision documents. The remedial system is performing as expected. However, the most recent (PEST) groundwater modeling results indicate that groundwater cleanup levels (PCE and TCE) are not expected to be achieved within the timeframe stated in the ROD (based on a transport modeling simulation that considered only TCE). (Note that the restoration timeframe estimated using the PEST modeling approach is similar to the timeframe presented in the ROD for PCE, refer to Section 5.13.5.1). A modeling-based remedial system optimization assessment is planned for 2013 which will update the estimated restoration timeframe for both PCE and TCE. These updated restoration timeframe approximations will be compared to the information presented in the ROD and will be used to determine whether the RAO related to aquifer restoration (see Section 5.13.3) is being achieved and is consistent with the expectations at the time of remedy selection.

Plume and remedial system monitoring is being conducted under the SPEIM/LTM and LUC programs and risk management measures are in place to ensure protection of human health and the environment. Operational costs are appropriate for the remedy and a robust optimization program continues with the objective of reducing remedial system operational timeframes, the time to reach remedial goals (e.g., MCLs/MMCLs/GW-1 Standards), and reducing future costs. Monitoring and evaluation activities are continual and well-documented.

5.13.6.2 Question B: Are the exposure assumptions, toxicity data, cleanup levels, and remedial action objectives (RAOs) used at the time of the remedy selection still valid?

Changes in Standards and To-Be Considered: There have been no changes in standards or TBC guidance.

Changes in Exposure Pathways: There have been no changes to exposure pathways or land use of the site that would affect the protectiveness of the remedy. It is noted that a more thorough evaluation of the VI pathway was completed at LF-1 since the completion of the ROD and the VI pathway was found to be incomplete (AFCEE 2012a).

Changes in Toxicity and Other Contaminant Characteristics: There have been changes in the toxicity factors that were in place at the time of the last Five Year Review (i.e., 2007) for the LF-1 groundwater COCs PCE, TCE, CCl_4, and 1,1,2,2-TeCA.

For PCE, the carcinogenic toxicity values (oral and inhalation) became less conservative, while the non-cancer toxicity values (oral and inhalation) became more conservative but by less than an order of magnitude (EPA 2013). These toxicity changes for PCE did not lead to a change in the MCL of 5 µg/L.

For TCE, the carcinogenic toxicity values (oral and inhalation) and oral non-cancer toxicity value became less conservative, while the inhalation non-cancer toxicity value is now 17.5 times more conservative. TCE was classified as a mutagen by EPA in November 2011 (EPA 2013). This means that when performing risk calculations, the TCE toxicity values need to be multiplied by adjustment factors to address the vulnerability of earlier aged receptors. These toxicity changes for TCE did not lead to a change in the MCL of 5 µg/L.

For CCl_4, the carcinogenic toxicity values (oral and inhalation) and oral non-cancer toxicity values became less conservative, while the inhalation non-cancer toxicity value became more conservative but by less than an order of magnitude (EPA 2013). These toxicity changes for CCl_4 did not lead to a change in the MCL of 5 µg/L.

For 1,1,2,2-TeCA, there has been no change in carcinogenic toxicity values since the last Five Year Review. However, EPA added an oral non-cancer toxicity value for 1,1,2,2-TeCA in September 2010 (EPA 2013). These toxicity changes for 1,1,2,2-TeCA did not lead to a change in the Massachusetts GW-1 standard of 2 μg/L.

In conclusion, since the RAOs and risk management decisions associated with LF-1 groundwater are based on MCLs/MMCLs/GW-1 Standards, these changes in toxicity values do not affect the protectiveness of the remedy. However, these updated toxicity values (or values derived from future updates) should be used when performing the residual risk assessment as part of the three-step process to achieve site closure (AFCEE 2011b).

Changes in Risk Assessment Methods: There were no changes in risk assessment methodology.

Review of RAOs: The RAOs developed for the ROD (AFCEE 2007) and revised in the 2011 ESD (AFCEE 2011b) are appropriate and remain valid.

5.13.6.3 Question C: Has any other information come to light that could call into question the protectiveness of the remedy?

No.

5.13.7 Issues, Recommendations, and Follow-Up Actions

Contaminant transport modeling completed since the ROD indicate that the restoration timeframe predicted at the time of remedy selection (i.e., by 2045) may not be met, however the current estimates contain considerable uncertainty.

An optimization assessment of the LF-1/CS-23 remedial system will be performed with an updated plume shell that more closely represents the current distribution of contamination within the plume. The optimization evaluation will assess the performance of the remedial system, determine whether improvements can be made, and update the restoration timeframe prediction for comparison to the information presented

in the ROD. If necessary at the conclusion of the optimization assessment, an ESD presenting the updated prediction for aquifer restoration timeframe will be completed. AFCEC should continue to monitor the wetland and vernal pool near LF-1/CS-23 for potential ecological impacts associated with the surface water drawdown due to the operation of the remedial system.

In addition, the topic of emerging contaminants should be monitored as it relates to groundwater at the MMR. Specifically for LF-1 groundwater, a sampling and analysis plan shall be submitted to the regulatory agencies to assess the possible presence of 1,4-dioxane.

5.13.8 Protectiveness Statement

The remedy for the LF-1 groundwater plume is protective of human health and the environment. The remedial system is performing as expected and the LUCs are in place and are functioning as intended. Through the combination of the active treatment by the remedial systems and natural attenuation processes, groundwater cleanup levels are expected to be achieved. However, there is some uncertainty in the model-predicted restoration timeframe that will be further assessed. When an updated estimate of the aquifer restoration timeframe is available, it will be determined whether the RAO of restoring the aquifer in a reasonable timeframe is being met. Since the LUCs are in place and are functioning as intended to prevent exposure and there are no current plans to use the portion of the aquifer where LF-1 contamination remains for water supply, the remedy remains protective.

5.13.9 References

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5.14 STORM DRAIN-5 (SD-5) GROUNDWATER

The SD-5 groundwater plume was a dissolved-phase groundwater plume which was located in the southeast corner of the MMR. The groundwater contamination at SD-5 has not been delineated as a contiguous plume since 2005 due to its limited extent. For reference, the 2005 SD-5 plume boundary is shown on **Figure 5-14A**. The SD-5 plume was defined as the extent of groundwater containing the COC TCE at concentrations greater than the MCL of 5 µg/L (AFCEE 2006).

5.14.1 Site Chronology

1983: SD-5 was first identified as a potentially hazardous site during the Phase I Records Search for the MMR (ANG 1983).

1986: An expanded records search was completed that identified potential source areas in the area of SD-5 (ANG 1986).

1988: An SI was conducted (ANG 1990).

1990-1994: A DSRP was completed which included the SD-5 source area. In addition, vicinity buildings and structures were demolished (ANG 1994).

1989-1996: An interim RI was completed in 1992 (ANG 1992) which was supplemented with additional data in 1996 (AFCEE 1996).

1994-1995: The NGB, DOD, EPA, MassDEP, and local communities approved a Plume Response Plan that presented an accelerated effort toward "simultaneous containment" of seven groundwater plumes including SD-5. An IROD for the seven groundwater plumes emanating from the MMR was signed on 25 September 1995 (ANG 1995). The IROD stated that groundwater extraction and treatment systems should be designed, installed, and operated until a final remedy for the site is chosen. The interim remedy for the SD-5 plume included extraction of contaminated groundwater and discharge of treated water to groundwater and institutional controls.

1996-2004: Installation and startup of the SD-5 interim remedial systems under the IROD (AFCEE 2006). The SD-5 system operated until February 2004.

2004: Completion of a feasibility study for SD-5 groundwater (AFCEE 2004).

2005: Proposed Plan issued (AFCEE 2005b).

2006: Completion of a ROD for SD-5 groundwater (AFCEE 2006). The selected remedy for SD-5 groundwater as specified in the ROD was LTM with LUCs.

2011: An ESD was prepared that clarified the inclusion of MNA as a component of the selected remedy, revised the LUCs, slightly modified the phrasing of the RAOs, and added text regarding the MMR three-step process to achieve site closure (AFCEE 2011).

5.14.2 Background

5.14.2.1 History of Contamination

The source of the SD-5 plume was the result of releases from a leaching well at the Non-Destructive Inspection Laboratory (NDIL), a Corrosion Control Shop, and sumps in two aircraft hangers (ANG 1994) located with the vicinity of Branshaw Street on the MMR (**Figure 5-14A**).

Source area remedial actions including the demolition of buildings/hangers and removal of leaching wells and drainage structures were conducted between 1990 and 2003. The ANG removed approximately 700 gallons of contaminated fluid from an NDIL leaching well in 1990 and the NDIL leaching well was removed in 1996. This removal action was completed as part of the MMR drainage structure removal program and also included the removal of four other drainage structures at SD-5 in 1996 (AFCEE 2006). Excavation of contaminated soils at the SD-5 source area began in April 2001. Approximately 6,500 tons of soil were removed and taken off-site for disposal at a state-permitted landfill. In August 2002, an SVE system was installed at the site to remediate VOCs in the subsurface. The SVE system removed approximately 5 lbs of VOCs and was shut down in August 2003 with concurrence from the regulatory agencies (AFCEE 2005a).

5.14.2.2 Physical Characteristics, Land and Resource Use

As shown on **Figure 5-14A**, the SD-5 groundwater site is split into two areas, SD-5 North (SD-5N) which is located on-base and SD-5 South (SD-5S) which is located off-base. When last able to be delineated in 2005, the SD-5 plume consisted of a series of disconnected small zones of contamination where TCE concentrations remained above the MCL (**Figure 5-14A**) although MCL exceedances remain in two of the three wells still monitored at SD-5 (**Figure 5-14B**).

The area above the on-base portions of the SD-5 area consists primarily of the airfield and associated facilities. The off-base area south of the MMR boundary is primarily residential and undeveloped woodland. Ashumet Pond and Johns Pond to the south are used for fishing, swimming, and boating. The topography of the land above the historic SD-5 plume footprint is generally flat but slightly undulating in the area between Ashumet Pond and Johns Pond. Sub-regionally, the area is characterized by low rolling hills and flat areas on a gently southward-sloping glacial outwash plain (AFCEE 2006). Within the footprint of the historic plume, the maximum and minimum ground surface elevations are approximately 116 ft msl and 38 ft msl, respectively.

5.14.2.3 Initial Responses

A summary of the initial responses is as follows:

Non-CERCLA Actions

None.

CERCLA Actions

The DoD and EPA, with concurrence from the MassDEP, implemented an interim action for the SD-5 groundwater plume and six other MMR plumes under an IROD (ANG 1995). The selected interim remedy for the SD-5 plume included extraction of

contaminated groundwater and discharge of treated water to groundwater (and/or other beneficial use) and institutional controls.

The TRET, established in 1996 as part of a new IROD management process, reviewed wellfield designs and determined that the 60-percent design for containment of several of the IROD plumes would cause negative ecological impacts (TRET 1996). The proposed interim remedy for the LF-1 groundwater plume was then revised to include the design and installation of a remedial system to capture the SD-5 North and South plumes.

Based on the investigational history and nature of the SD-5 South plume, a phased design and construction approach was adopted. Phase I addressed the axial portion of the plume and included two recirculating wells. Phase II addressed the southernmost portion of the plume and included one extraction well for the SD-5 South plume with treatment at the SRTF.

The SD-5 groundwater contaminants were largely removed by the three interim remedial systems including: SD-5N ETR System; SD-5S Axial Recirculation Well System; and the SD-5S Hoophole Road Extraction Well System (**Figure 5-14A**). Descriptions of these systems are provided below and further details are included in the ROD (AFCEE 2006).

- SD-5N ETR System: The SD-5N ETR system began operation in August 1997 and consisted of 10 closely-spaced extraction wells, GAC, and eight reinjection wells. The extracted groundwater was treated at the SRTF. After treatment, the water was returned to the aquifer through a series of eight reinjection wells situated hydraulically crossgradient of the extraction wells along the MMR boundary. The SD-5 North ETR system operated in various configurations until August 2003 when the final extraction well was shutdown.
- SD-5S Axial System (Phase I): The SD-5S Axial Recirculating Well Remedial System began operation in June 1999 and consisted of two recirculating wells located axially in the southern portion of the SD-5S plume. Water treatment consisted of air stripping within the wellhead vault, followed by filtration of the air stream by primary and secondary GAC units. The treatment systems were housed in below-grade vaults installed at each recirculating well location. The SD-5S Phase I Axial System operated until April 2003.
- SD-5S Hoophole Road Extraction Well System (Phase II): The SD-5S Hoophole Road remedial system consisted of one extraction well in the SD-5S plume. It

should be noted that this system was constructed in conjunction with an extraction well for the CS-10 Northern lobe which was also located along Hoophole Road and is still in operation (Section 5.3). Extracted groundwater was pumped to the SRTF for treatment and the treated water was reinjected into the aquifer through a combination of the SD-5N reinjection wells and the CS-10 Sandwich Road reinjection wells. Phase II treatment began operation in January 2000. On 25 February 2004, the SD-5S Hoophole Road extraction well was turned off.

5.14.2.4 Basis for Taking Action

The baseline cancer risk calculations indicated that unless remedial action is undertaken, future residential exposure to contaminated groundwater at SD-5 may present an excess lifetime cancer risk greater than the acceptable MassDEP threshold of $1x10^{-5}$ and the acceptable EPA range of $1x10^{-4}$ to $1x10^{-6}$ (AFCEE 2006).

An ecological risk assessment was conducted for SD-5 groundwater and no ecological risks were identified (AFCEE 2006).

5.14.3 Remedial Actions

The final remedy for the SD-5 plume was determined in the *Final Record of Decision for Groundwater at Eastern Briarwood, Western Aquafarm, and Storm Drain-5* (AFCEE 2006) which was signed on 28 September 2006. The RAOs for the SD-5 groundwater plume as presented in the ROD (AFCEE 2006) and modified in the ESD (AFCEE 2011) are as follows:

- Prevent residential exposure to SD-5 groundwater with TCE concentrations greater than the MCL of 5 µg/L.
- Restore useable groundwaters to their beneficial uses wherever practicable, within a timeframe that is reasonable given the particular circumstances of the site.

5.14.3.1 Remedy Selection and Implementation

The selected remedy for SD-5 groundwater in the ROD (AFCEE 2006) was LTM with LUCs. In addition, CERCLA reviews are to be completed every five years throughout the lifetime of the remedial action.

LTM data collected under the SPEIM/LTM program are used to assess: (i) whether the remedial objectives are being met, including determining whether plume concentrations are stable or reducing; and (ii) to identify and assess optimization opportunities. The data collected under the SPEIM/LTM program are presented to the regulatory agencies through the Technical Update meeting process and documented in project note submittals.

As part of the LUC process specified in the ROD (AFCEE 2006) and ESD (AFCEE 2011), a private well verification survey was completed at SD-5 between November 2012 and July 2013 (AFCEC 2013). The private well verification survey completed at the SD-5 LUC area consisted of outreach to 31 parcels. Responses were obtained from 100 percent of the property owners within the SD-5 LUC area and no active private wells were identified. Thirteen properties were determined to have a private well that is non-operational or has been disconnected. Technical evaluations were completed for each private well to determine whether these wells could represent a future exposure risk to SD-5 groundwater (should they be restarted by the property owner). No private wells that were identified present a current or future unacceptable exposure risk to the SD-5 groundwater (AFCEC 2013). In the event that new private well information is obtained or plume monitoring data indicate a change to the SD-5 CSM, AFCEC will perform the necessary well determinations at the time the information becomes available.

5.14.3.2 Remedy Operation & Maintenance

The periodic LTM costs associated with ongoing remedial action at SD-5 are generally consistent with those predicted at the time of remedy selection (with consideration for savings associated with optimization initiatives such as less frequent sampling as was assumed at the time of the remedy selection) and do not indicate potential remedy problems.

5.14.4 Progress Since the Last Five Year Review

Per the EPA guidance document (EPA 2001), this section summarizes the progress made on the specific recommendations and follow-up actions presented in the prior third CERCLA Five Year Review (AFCEE 2008b). For the SD-5 groundwater, the recommendations and follow-up actions were:

1) Section 4.1 of the third Five Year Review recommended that a screening level VI evaluation be completed for each IRP groundwater site. The objective of the VI evaluation was to determine if a VI exposure pathway exists at a particular site, and if so, complete a screening level evaluation to determine if VI risk above target levels is likely or unlikely.

2) Section 4.3 of the third Five Year Review recommended that, in order to ensure long term protectiveness, all groundwater sites with off-base plume areas must undergo the well verification process as described in AFCEC's guideline titled *Verification, Decommissioning, and Documentation Guidelines for Private Wells in Areas of Potential Concern* (AFCEE 2008c). It was recommended that this requirement be codified in an ESD for those off-base groundwater sites with RODs that do not currently contain the well verification language as part of the required LUCs. For off-base groundwater sites without final RODs at the time of the third Five Year Review (AV and CS-10), the well verification language should be included in the LUC requirements presented in the Final RODs.

3) The RAOs in the ROD required that the Air Force "prevent or reduce residential exposure". The third Five Year Review recommended that the RAOs be modified to eliminate the word "reduce" to better ensure long-term protectiveness.

Progress since the last Five Year Review against these recommendations and follow-up actions is as follows:

1) A VI evaluation was completed for the 16 IRP groundwater sites at the MMR as documented in the *Final 2011 MMR Vapor Intrusion Evaluation Technical Memorandum* (AFCEE 2012) including SD-5. The VI evaluation indicated the

VI exposure pathway is either incomplete or insignificant at SD-5 and no further monitoring or data collection is needed specific to VI at SD-5. However, as part of the ongoing remedial actions at SD-5, AFCEC will continue to monitor the nature and extent of the SD-5 groundwater contamination under the SPEIM/LTM program and will re-evaluate the VI exposure pathway if conditions change such that VI could be a concern.

2) The *Final Explanation of Significant Differences for the Installation Restoration Program Groundwater Plumes at the Massachusetts Military Reservation* (AFCEE 2011) was signed on 14 September 2011 and included the requirement to complete the private well verification portion of the LUCs at SD-5 within three years of the signing of the ESD. This well verification effort was completed in July 2013 and concluded that no private wells that were identified present an unacceptable exposure risk from SD-5 groundwater (AFCEC 2013). Further details of the well verification process and findings are included in Section 5.14.3.1.

3) The 2011 ESD for the IRP groundwater plumes (AFCEE 2011) modified the phrasing of the RAOs to remove the word "reduce". The revised RAOs are presented in Section 5.14.3.

5.14.5 Five Year Review Process

5.14.5.1 Data Review

The data collected under the SPEIM/LTM program are continually assessed by a team of on-site professional staff and the results of these assessments are presented to the regulatory agencies initially during Technical Update meetings and then through technical memoranda or project note deliverables, if warranted, based on the results of the data evaluation or to address particular plume issues. The following technical deliverables were prepared that assessed remedial progress:

- *Storm Drain-5 Long Term Monitoring 2008 Biennial Project Note* (AFCEE 2008a)
- *Storm Drain-5 Long Term Monitoring 2010 Biennial Project Note* (AFCEE 2010)
- *Storm Drain-5 Long Term Monitoring 2012 Biennial Project Note* (AFCEC 2012)

While additional details are provided in the documents listed above, the primary findings and conclusions from these performance evaluations at SD-5 are as follows:

1. Modeling completed at the time of the ROD predicted contaminant concentrations in the SD-5 area would decrease below the MCL by approximately 2008 (AFCEE 2006). TCE has not been detected at concentrations exceeding the MCL in the SD-5N monitoring network since 2008.

2. TCE contamination has been more persistent in groundwater sampled from the two SD-5S monitoring network wells, 00MW0524B and 28MW0035B (**Figure 5-14B**). TCE concentrations fluctuated from 5.4 to 10 µg/L at 00MW0524B and from 4.6 to 11 µg/L at 28MW0035B during this Five Year Review period (AFCEC 2012). Both of these monitoring wells are screened within a relatively low permeability silty sand layer which is likely playing a role in the persistent nature of the residual contamination. Based on the results from direct push drilling completed hydraulically upgradient of each of the two wells that remain in the SD-5S monitoring network, and on LTM data collected from downgradient wells, contamination at these two locations is not contiguous or extensive.

3. Since the two monitoring network wells where TCE MCL exceedances remain are both screened in a relatively low permeability layer, the contamination is likely not migrating very far downgradient and is expected to attenuate over time.

4. Plume monitoring under AFCEC's SPEIM/LTM program should continue at SD-5 to provide the necessary data to manage potential exposure risks, determine when RAOs have been met, and evaluate optimization opportunities.

5.14.5.2 Site Inspection

Refer to Section 3.5.

5.14.5.3 Interviews

Refer to Section 3.6.

5.14.6 Technical Assessment

The technical assessment component of the Five Year Review consists of evaluating the protectiveness of the remedy. The technical assessment is based on EPA guidance provided in Section 4.0 of the Comprehensive Five Year Review Guidance (EPA 2001).

5.14.6.1 Question A: Is the remedy functioning as intended by the decision documents?

Yes, the LTM activities and the implementation of the LUCs at SD-5 have resulted in the remedy functioning as intended by the decision documents. The restoration timeframe predicted in the ROD (2008) has been achieved at SD-5N; however, TCE concentrations have not yet consistently reached the MCL at SD-5S as was expected at the time of remedy selection. Operational costs are appropriate for the remedy. Monitoring and evaluation activities are continual and well-documented and should continue.

5.14.6.2 Question B: Are the exposure assumptions, toxicity data, cleanup levels, and remedial action objectives (RAOs) used at the time of the remedy selection still valid?

Changes in Standards and To-Be Considered: There have been no changes in standards or TBC guidance.

Changes in Exposure Pathways: There have been no changes to exposure pathways or land use of the site that would affect the protectiveness of the remedy. It is noted that since the VI exposure pathway was not considered in the RI, a screening evaluation has been completed and the VI pathway was found to be incomplete or insignificant at SD-5 (AFCEE 2012).

Changes in Toxicity and Other Contaminant Characteristics: There has been a change in the toxicity factors that were in place at the time of the last Five Year Review (i.e., 2007) for the SD-5 groundwater COC, TCE.

The carcinogenic toxicity values for TCE (oral and inhalation) and oral non-cancer toxicity value became less conservative, while inhalation non-cancer toxicity value is now 17.5 times more conservative. TCE was classified as a mutagen by EPA in November 2011 (EPA 2013). This means that when performing risk calculations, the TCE toxicity values need to be multiplied by adjustment factors to address the vulnerability of earlier aged receptors. These toxicity changes for TCE did not lead to a change in the MCL of 5 µg/L.

Since the RAOs and risk management decisions associated with SD-5 groundwater are currently based on the MCL for TCE, these changes in toxicity values do not affect the protectiveness of the remedy. However, the updated toxicity values for TCE (or values derived from future updates) should be used when performing the residual risk assessment as part of the three-step process to achieve site closure (AFCEE 2011).

Changes in Risk Assessment Methods: There were no changes in risk assessment methodology.

Review of RAOs: The RAOs developed for the final ROD (AFCEE 2006) and revised in the ESD (AFCEE 2011) are appropriate.

5.14.6.3 Question C: Has any other information come to light that could call into question the protectiveness of the remedy?

No.

5.14.7 Issues, Recommendations, and Follow-Up Actions

An ESD should be prepared to update the aquifer restoration timeframe estimate for SD-5S.

In addition, the topic of emerging contaminants should be monitored as it relates to groundwater at the MMR. Specifically for SD-5 groundwater, a sampling and analysis plan shall be submitted to the regulatory agencies to assess the possible presence of 1,4-dioxane.

5.14.8 Protectiveness Statement

The remedy for the SD-5 groundwater plume is protective of human health and the environment. The LTM program is ongoing and the LUCs are in place and are functioning as intended. Through pre-ROD operation of the SD-5 remedial system and natural attenuation processes, groundwater cleanup levels have been achieved at SD-5N and are expected to be achieved at SD-5S. However, the timeframe to achieve aquifer restoration at SD-5S will be longer than predicted in the ROD, primarily due to the presence of contamination in low hydraulic conductivity aquifer materials. Since the LUCs are in place and are functioning as intended and there are no current plans to use this portion of the aquifer for water supply, the remedy remains protective.

5.14.9 References

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FIGURES

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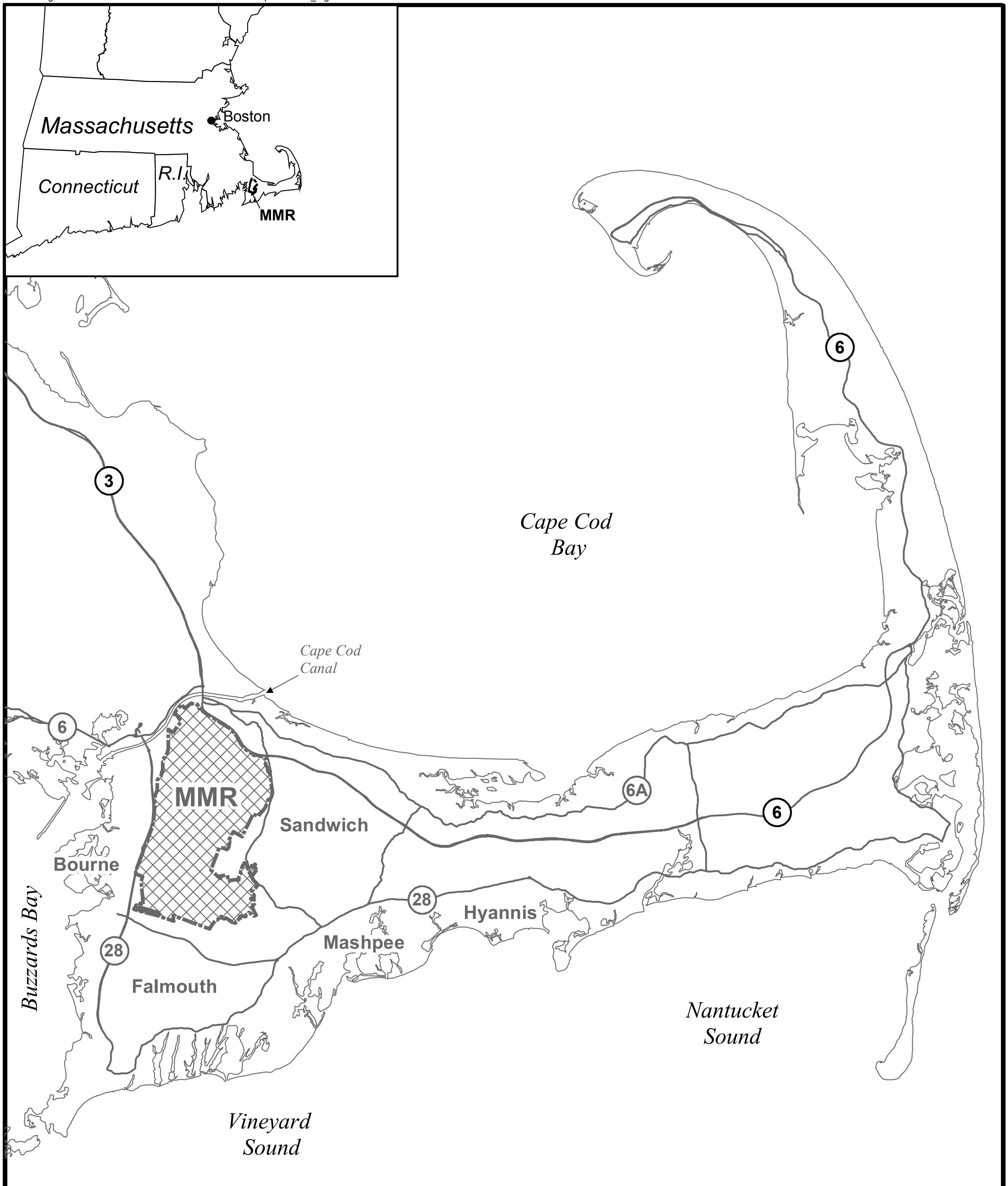

Legend

Massachusetts Military Reservation

Data Source: AFCEC, MMR-AFCEC Data Warehouse
MMR Boundary from Massachusetts Air National Guard 2011

0 3 6 Miles

FIGURE 1-1

MASSACHUSETTS MILITARY RESERVATION, CAPE COD, MASSACHUSETTS

AFCEC - Massachusetts Military Reservation
Final 4th Five-Year Review, 2007-2012

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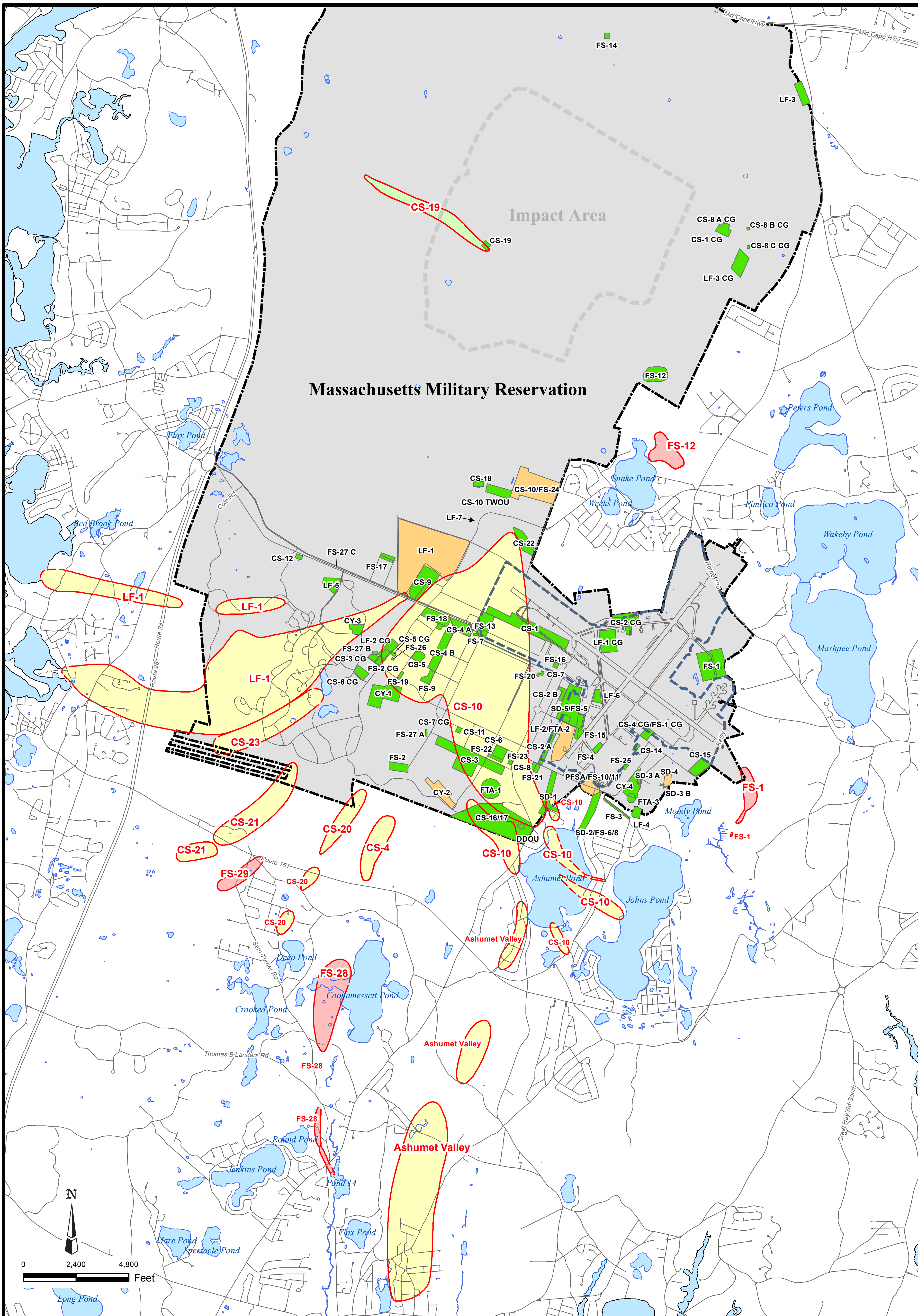

Data Source: AFCEC, June 2013, MMR-AFCEC Data Warehouse, MMR Boundary from Massachusetts Air National Guard 2011

Legend

- Massachusetts Military Reservation Boundary
- Plume Boundary (Dashed Where Inferred)
- Impact Area
- MMR Flight Line
- Source Areas Undergoing Five-Year Review*
- Source Areas Not Subject to Five-Year Review

*Coal Yard-2 not subject to Five Year review - see Section 4.2 for explanation.

Groundwater Plumes

- EDB Plume - Represent an exceedance of Ethylene Dibromide (1,2-dibromoethane), EDB MMCL = 0.02 µg/L
- TCE/PCE Plume - Represent an exceedance of Trichloroethene (TCE) and/or Tetrachloroethene (PCE), TCE and PCE MCL = 5.0 µg/L
- Explosives Plume Concentrations Above EPA Risk Based Concentration = 0.6 µg/L, Royal Demolition Explosive (RDX)

FIGURE 1-2

ALL MMR - IRP SITE LOCATIONS

AFCEC - Massachusetts Military Reservation

Final 4th Five-Year Review, 2007-2012

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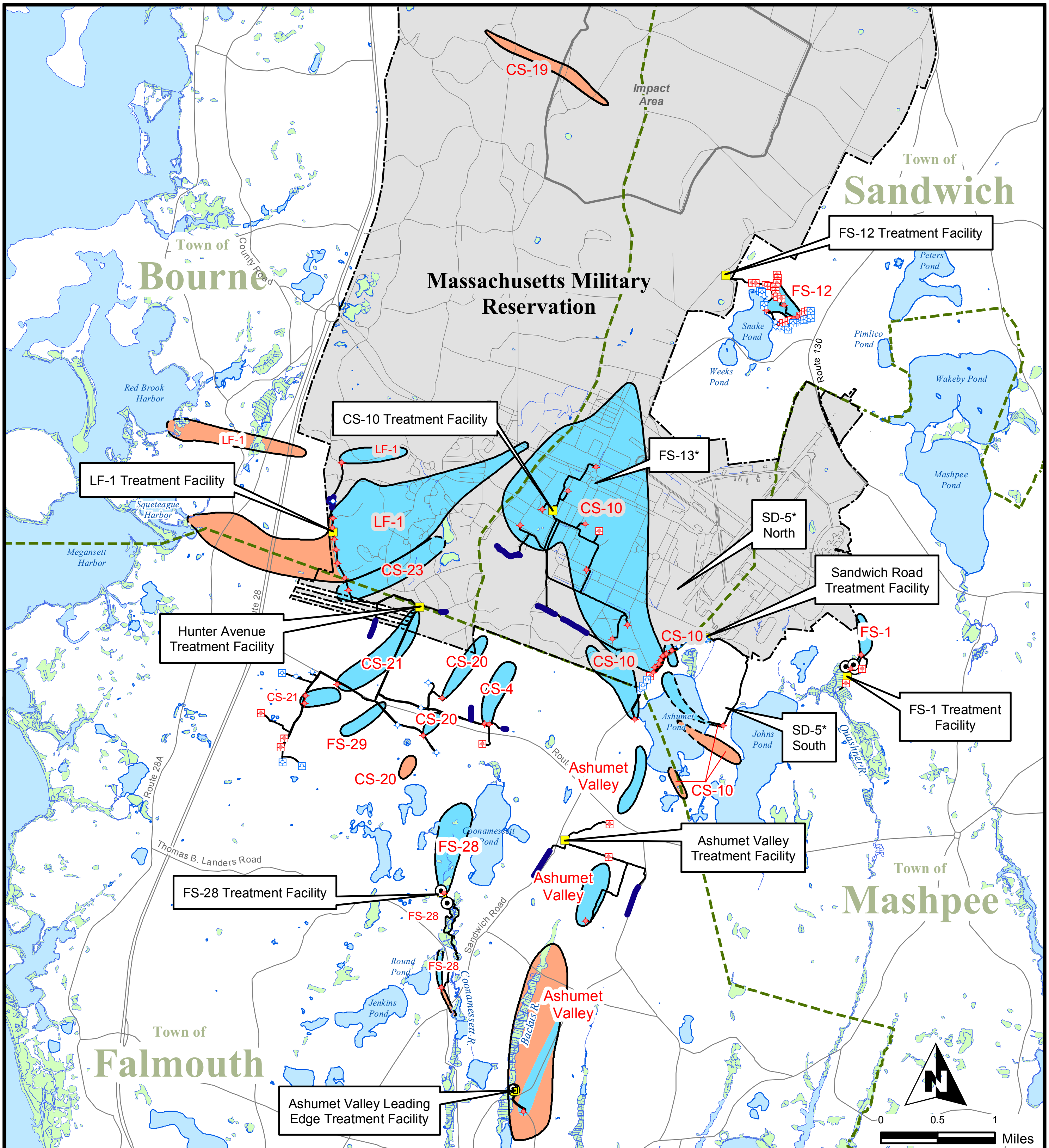

Legend

- Plume Boundary (Dashed Where Inferred) Defines Area of Groundwater Contaminants of Concern Above Regulatory Limits
- Treatment System Piping
- Infiltration Gallery/Trench
- Town Boundary
- Massachusetts Military Reservation Boundary
- Reinjection Well
- Extraction Well
- Reinjection Well (Off)
- Extraction Well (Off)
- Outflow Bubbler
- Treatment Facility
- Bog/Wetland
- Remedy Relies on Active Treatment and Natural Attenuation
- Remedy Relies on Natural Attenuation (*Includes FS-13 and SD-5)

Data Source: AFCEC, June 2013, AFCEC-MMR Data Warehouse
MMR Boundary from Massachusetts Air National Guard 2011

FIGURE 1-3

MMR IRP GROUNDWATER PLUMES AND REMEDIAL TECHNOLOGY DESIGNATION

AFCEC - Massachusetts Military Reservation

Final 4th Five-Year Review, 2007-2012

CH2MHILL.

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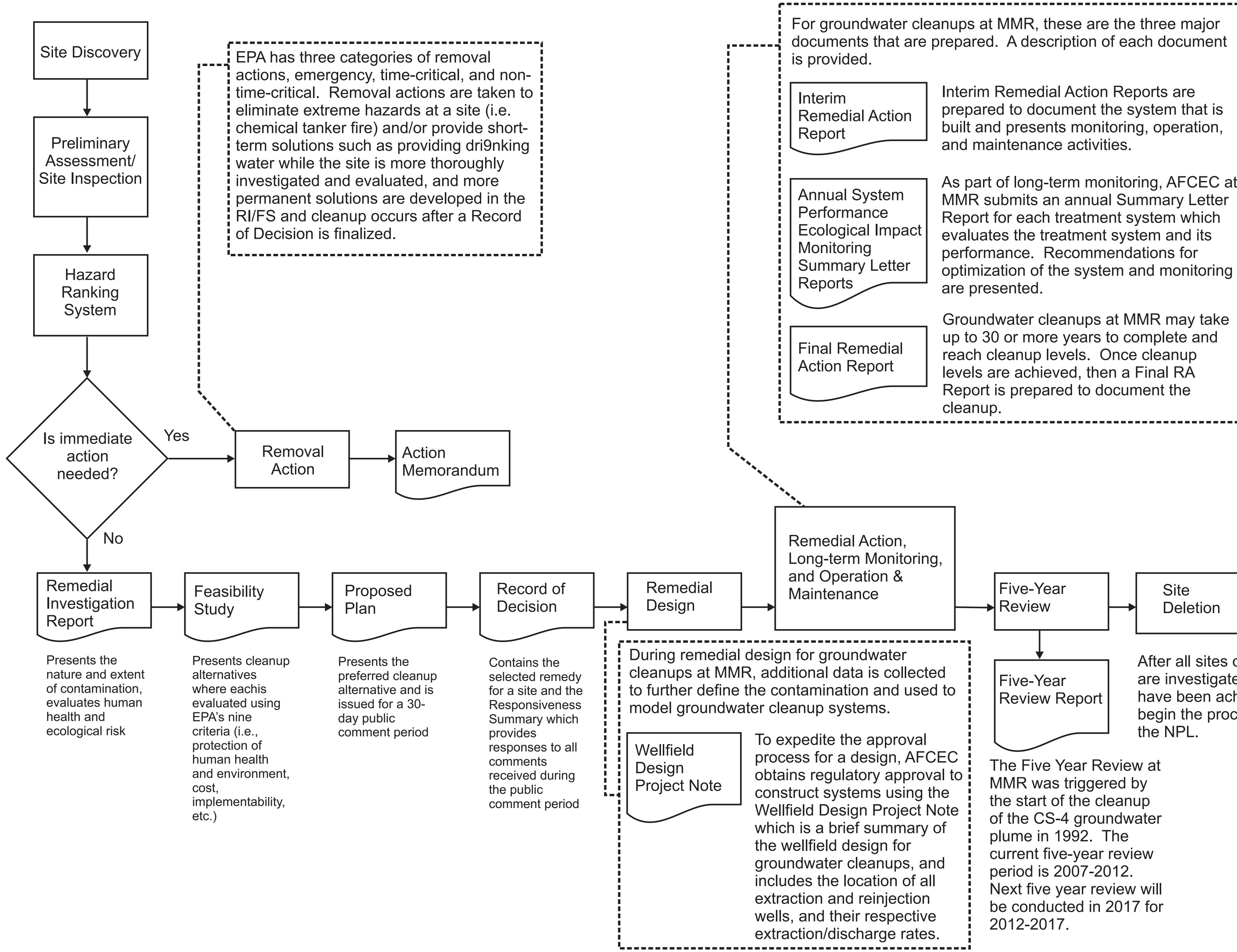
What is Superfund?
Superfund is the nickname for the environmental cleanup program legally known as the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), a federal law, enacted in 1980. Superfund provides the authority through which the Federal government can compel people or companies responsible for creating hazardous waste sites to clean them up. It also created a public trust fund, known as the Superfund, to assist with the cleanup of inactive and abandoned hazardous waste sites or accidentally spilled or illegally dumped hazardous materials.

See also EPA's Superfund Internet Resources
Superfund Process: http://www.epa.gov/superfund/action/process/sfprocess.htm
General Superfund: http://www.epa.gove/superfund/index.htm



This flowchart begins in the upper left with "Site Discovery" and is an overview of the Superfund process. A site is added to the National Priorities List and is called a Superfund Site if it has a score of 28.5 or greater using a scoring system which is called the Hazard Ranking System. Since the investigation and cleanup process takes several years, sites are evaluated early in the process to determine if any short-term actions or removal actions need to be taken. Details are provided in comments associated with certain steps in the flowchart. Typical Superfund sites have only one to three operable units and are smaller in comparison to federal facility sites such as the Massachusetts Military Reservation (MMR) which has over 80 sites in its Installation Restoration Program (IRP).

Legend

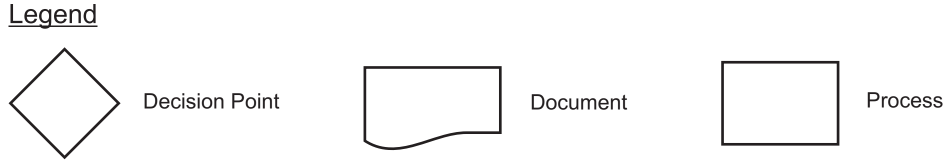


FIGURE 1-4

OVERVIEW OF THE SUPERFUND INVESTIGATION AND CLEANUP PROCESS
AFCEC - Massachusetts Military Reservation
Final 4th Five-Year Review, 2007-2012

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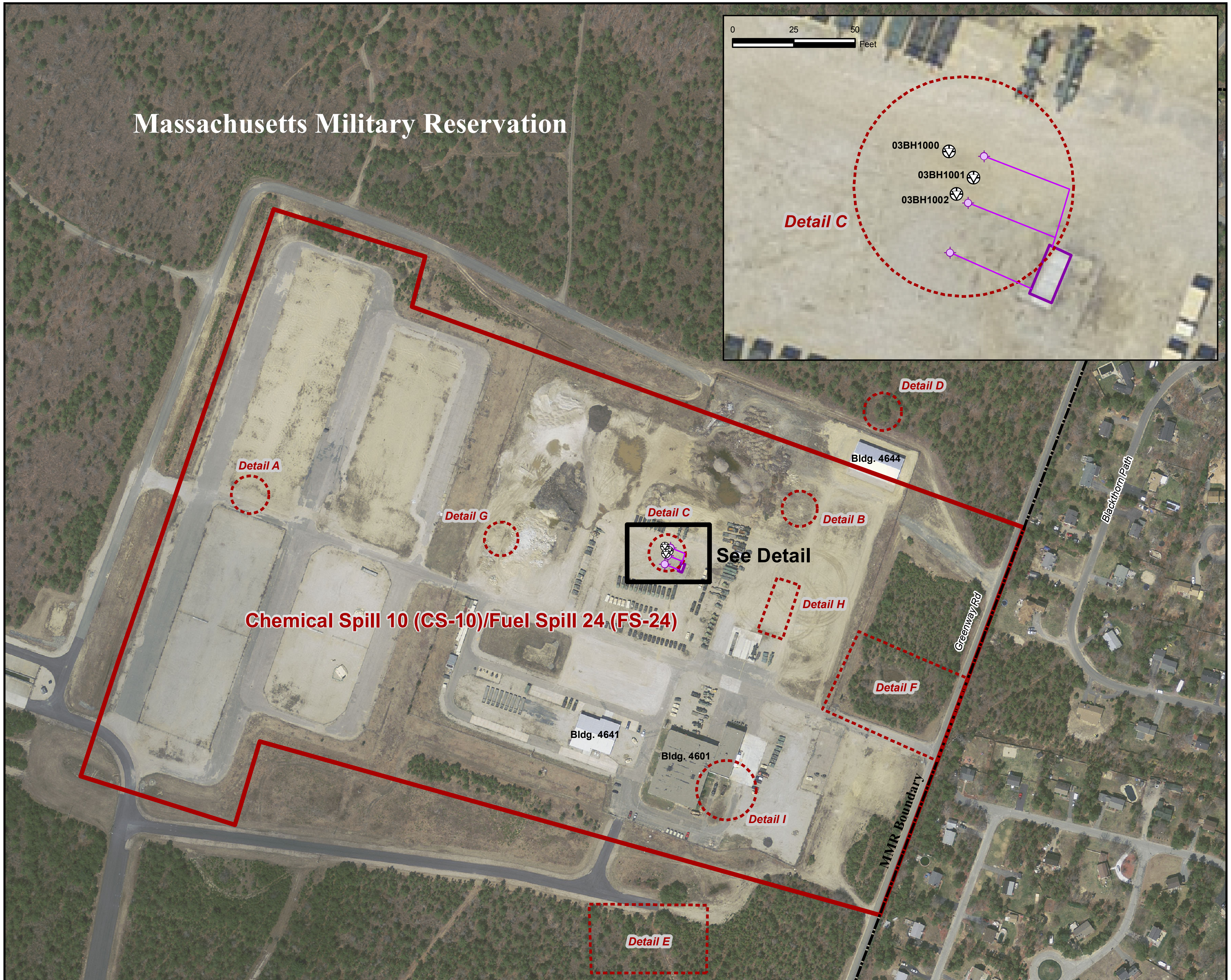

Legend

- Soil Vapor Extraction Well
- Direct Push Location
- Massachusetts Military Reservation Boundary
- Soil Vapor Extraction System Pipeline
- Source Area
- Source Area Detail
- Soil Vapor Extraction System Treatment Facility

0 125 250 Feet

Data Source: AFCEC, MMR-AFCEC Data Warehouse
MMR Boundary from Massachusetts Air National Guard 2011
2009 Aerial Photography from MassGIS

FIGURE 4-1

CS-10/FS-24 SOURCE AREA

AFCEC - Massachusetts Military Reservation

Final 4th Five-Year Review, 2007-2012

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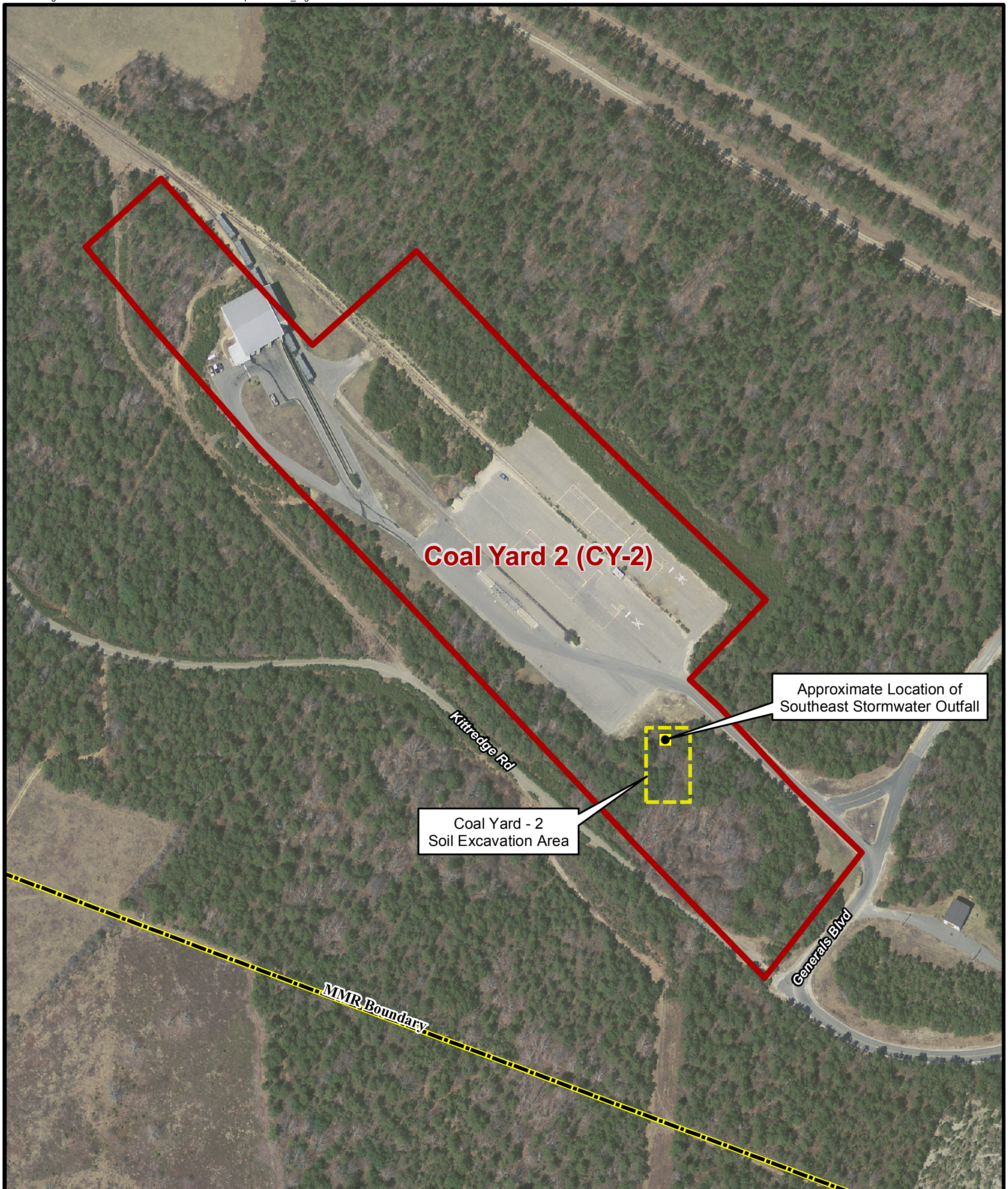

Data Source: AFCEC, MMR-AFCEC Data Warehouse
2009 Aerial Photography from MassGIS

Legend

- Source Area Boundary
- Massachusetts Military Reservation Boundary
- Stormwater Outfall

0 120 240 Feet

FIGURE 4-2

CY-2 SOURCE AREA
AFCEC - Massachusetts Military Reservation
Final 4th Five-Year Review, 2007-2012

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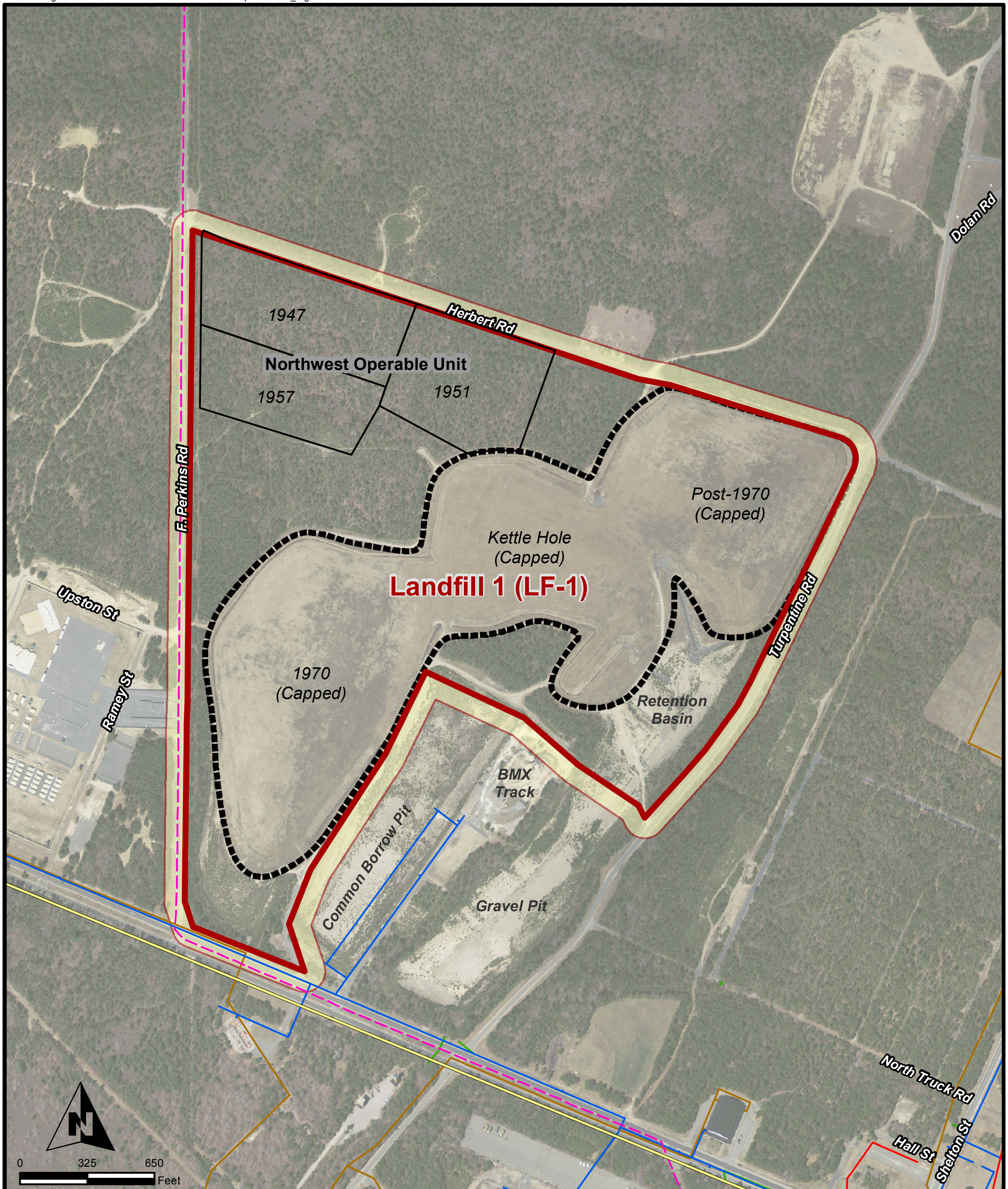

Data Source: AFCEC, MMR-AFCEC Data Warehouse
2009 Aerial Photography from MassGIS

Legend

- Source Area Boundary
- Capped Area
- Source Area 100' Buffer
- Northwest Operable Unit

Subsurface Utilities

- Electrical Primary Line
- Storm Water
- Water
- Wastewater
- Forced Effluent Water
- Gas (Approximate Location)

FIGURE 4-3

LF-1 SOURCE AREA

AFCEC - Massachusetts Military Reservation

Final 4th Five-Year Review, 2007-2012

CH2MHILL.

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Legend

- Massachusetts Military Reservation Boundary
- Source Area Boundary
- Petroleum-related Compounds in Groundwater Exceeded MCL, RBC, or MCP Method-1 GW-1 Standard (Refer to Table 4-2)
- Petroleum-related Compounds in Groundwater Do Not Exceed MCL, RBC, or MCP Method-1 GW-1 Standard (Refer to Table 4-2)

Note: GW1 = Groundwater-1
MCL = Maximum Contaminant Level
MCP = Massachusetts Contingency Plan
RBC = Risk-Based Concentration

Data Source: AFCEC, MMR-AFCEC Data Warehouse
MMR Boundary from Massachusetts Air National Guard 2011
2009 Aerial Photography from MassGIS

N

0 210 420 Feet

FIGURE 4-4

FTA-2/LF-2 SOURCE AREA

AFCEC - Massachusetts Military Reservation

Final 4th Five Year Review, 2007-2012

CH2MHILL

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Data Source: AFCEC, MMR-AFCEC Data Warehouse
2009 Aerial Photography from MassGIS

Legend

Source Area Boundary

N

0 30 60
Feet

FIGURE 4-5

LF-7 SOURCE AREA

AFCEC - Massachusetts Military Reservation

Final 4th Five-Year Review, 2007-2012

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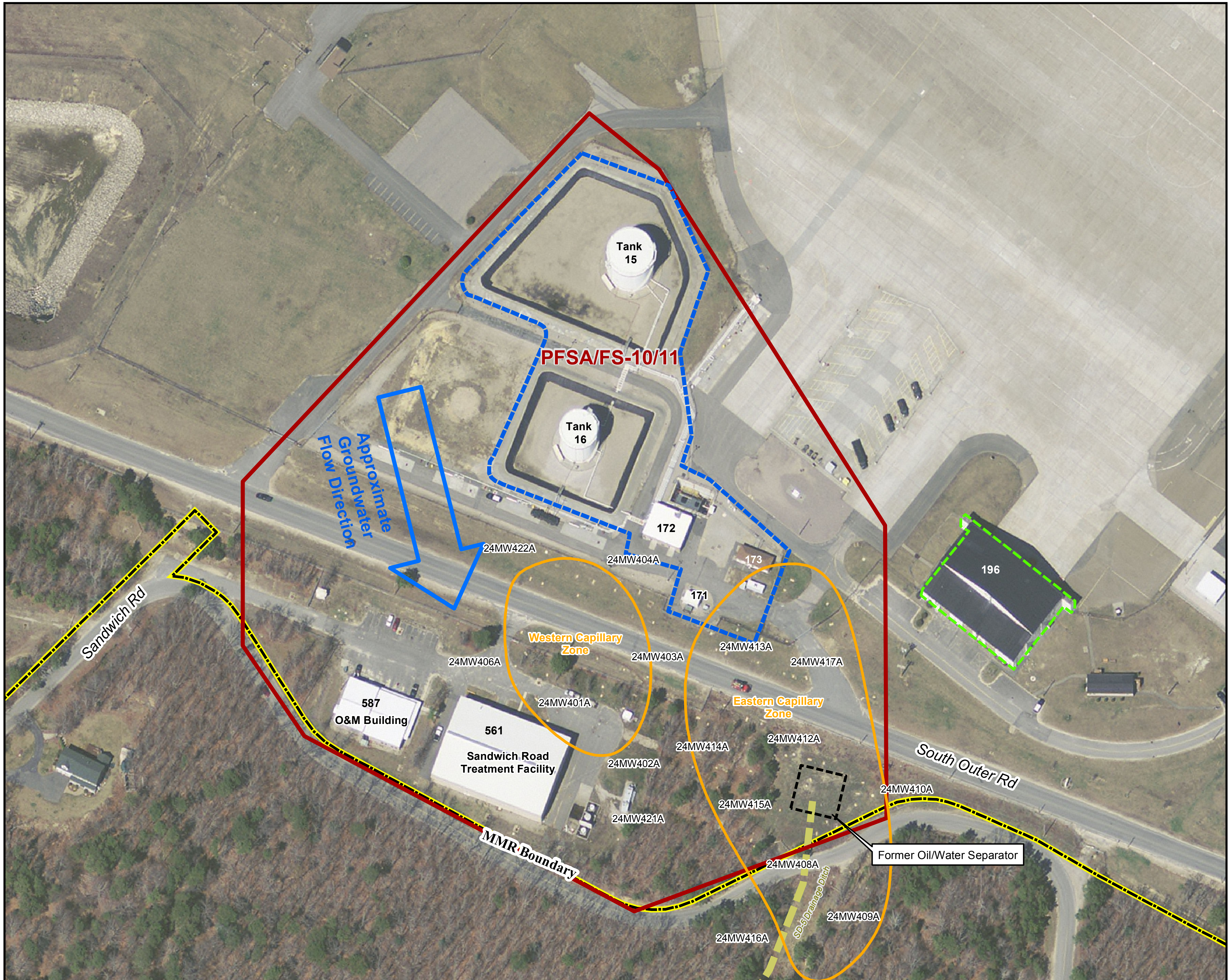

Legend

- Massachusetts Military Reservation Boundary
- Source Area Boundary
- PFSA Structures Demolished January/February 2011
- Building 196 Demolished Summer 2011
- 587 Building Number
- Approximate Historic Extent of Soil Contamination*
- Drainage Ditch
- Petroleum-related Compounds in Groundwater Exceeded MCL, RBC, or MCP Method-1 GW-1 Standard (Refer to Table 4-3)
- Petroleum-related Compounds in Groundwater Do Not Exceed MCL, RBC, or MCP Method-1 GW-1 Standard (Refer to Table 4-3)

Note: GW1 = Groundwater-1
MCL = Maximum Contaminant Level
MCP = Massachusetts Contingency Plan
RBC = Risk-Based Concentration

*Defined in *Operations and Maintenance Manual Biosparge/Vapor Recovery System for PFSA*. Prepared by Environmental Chemical Corporation for AFCEE/MMR Installation Restoration Program, Massachusetts Military Reservation, Cape Cod, MA, May 2003.

N

0 60 120 Feet

Data Source:
AFCEC, MMR-AFCEC Data Warehouse
2009 Aerial Photography from MassGIS
Numbers for Historic Tanks from Overall Demolition Plan OTS-120-104, Date May 22, 2009

FIGURE 4-6

PFSA (FS-10/FS-11) SOURCE AREA
AFCEC - Massachusetts Military Reservation
Final 4th Five-Year Review, 2007-2012

CH2MHILL.

Data Source: AFCEE, MMR-AFCEE Data Warehouse
2009 Aerial Photography from MassGIS

Legend

- Massachusetts Military Reservation Boundary
- Soil Sample Location
- Direct Push Location
- Source Area
- Historic Building Location

0 100 200 Feet

FIGURE 4-7

SD-4 SOURCE AREA

AFCEE - Massachusetts Military Reservation
Final 4th Five-Year Review, 2007-2012

CH2MHILL.

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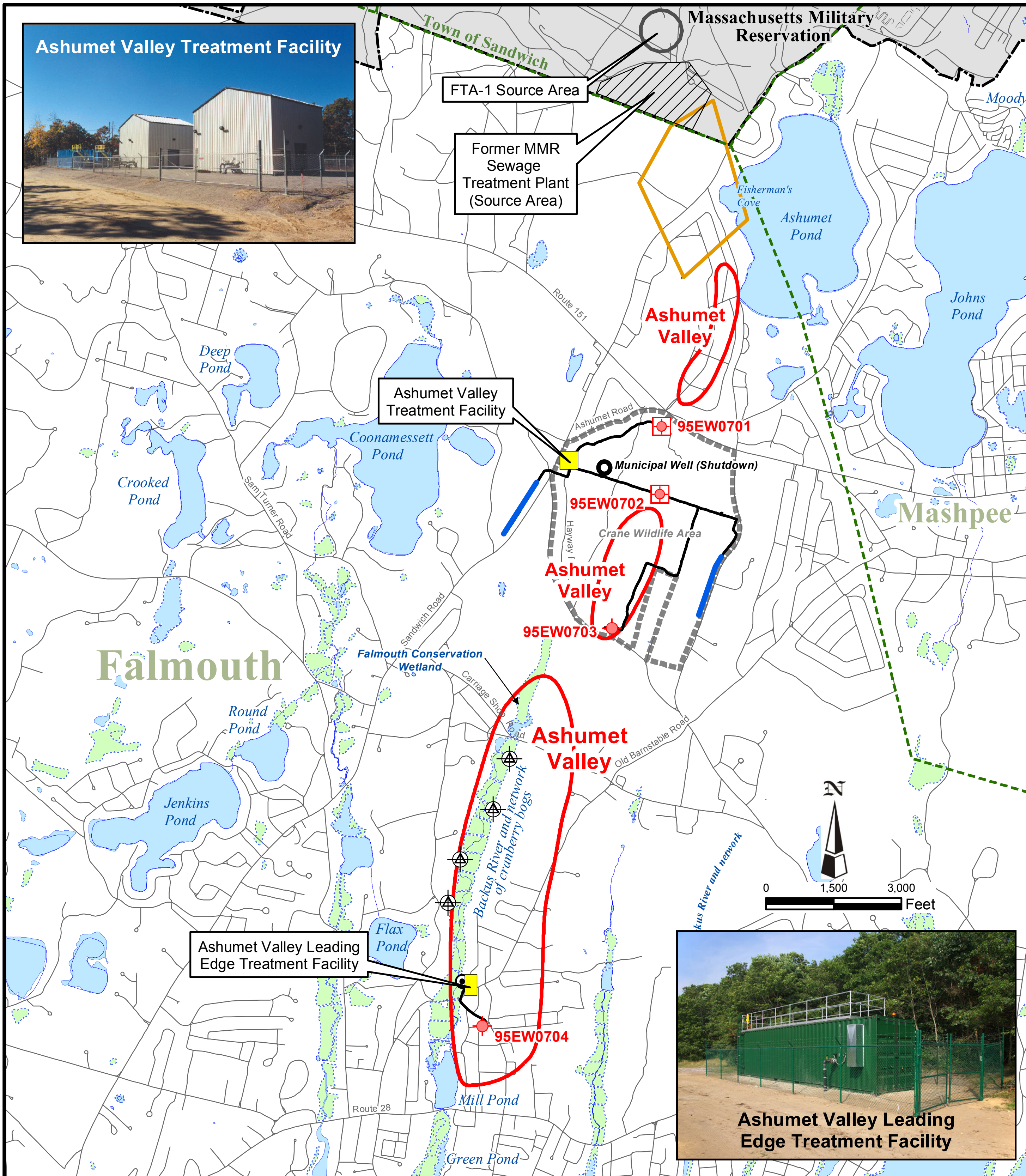

Legend

Data Source: AFCEC, February 2013, AFCEC-MMR Data Warehouse
MMR Boundary from Massachusetts Air National Guard 2011

- Ashumet Valley Plume Boundary = Concentrations exceeding drinking water standards or Maximum Contaminant Level (MCL), dashed where inferred. Represents an exceedance of trichloroethene (TCE) and/or perchloroethene (PCE)
  (TCE MCL = 5 µg/L)
  (PCE MCL = 5 µg/L)
- Treatment System Piping
- Manganese LTM Area
- Infiltration Trench
- Town Boundary
- Crane Wildlife Area Boundary
- Extraction Well (On)
- Extraction Well (Off)
- Irrigation Well
- Treatment Facility
- Public Water Supply Well
- Massachusetts Military Reservation Boundary
- Bog/Wetland

FIGURE 5-1A

ASHUMET VALLEY GROUNDWATER PLUME AND TREATMENT SYSTEMS

AFCEC - Massachusetts Military Reservation
Final 4th Five-Year Review, 2007-2012

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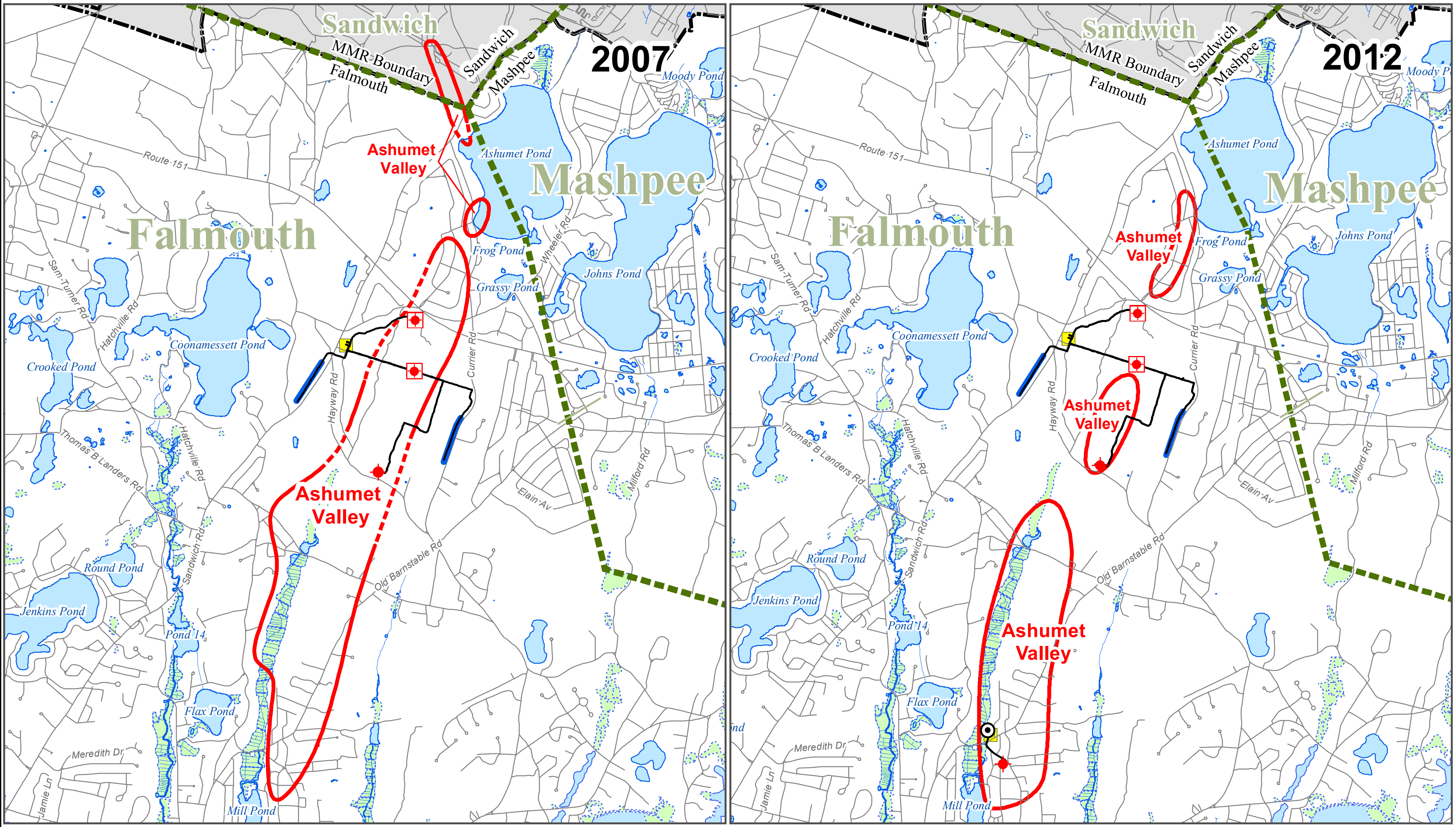


Legend

- Town Boundary
- Massachusetts Military Reservation Boundary
- Plume Boundary (Dashed Where Inferred)
- Bog/Wetland
- Extraction Well
- Extraction Well (Off)
- Bubbler
- Treatment System Pipeline
- Infiltration Trench
- Treatment Facility

Data Source: AFCEC, MMR-AFCEC Data Warehouse
MMR Boundary from Massachusetts Air National Guard 2011

0 2,200 4,400 Feet

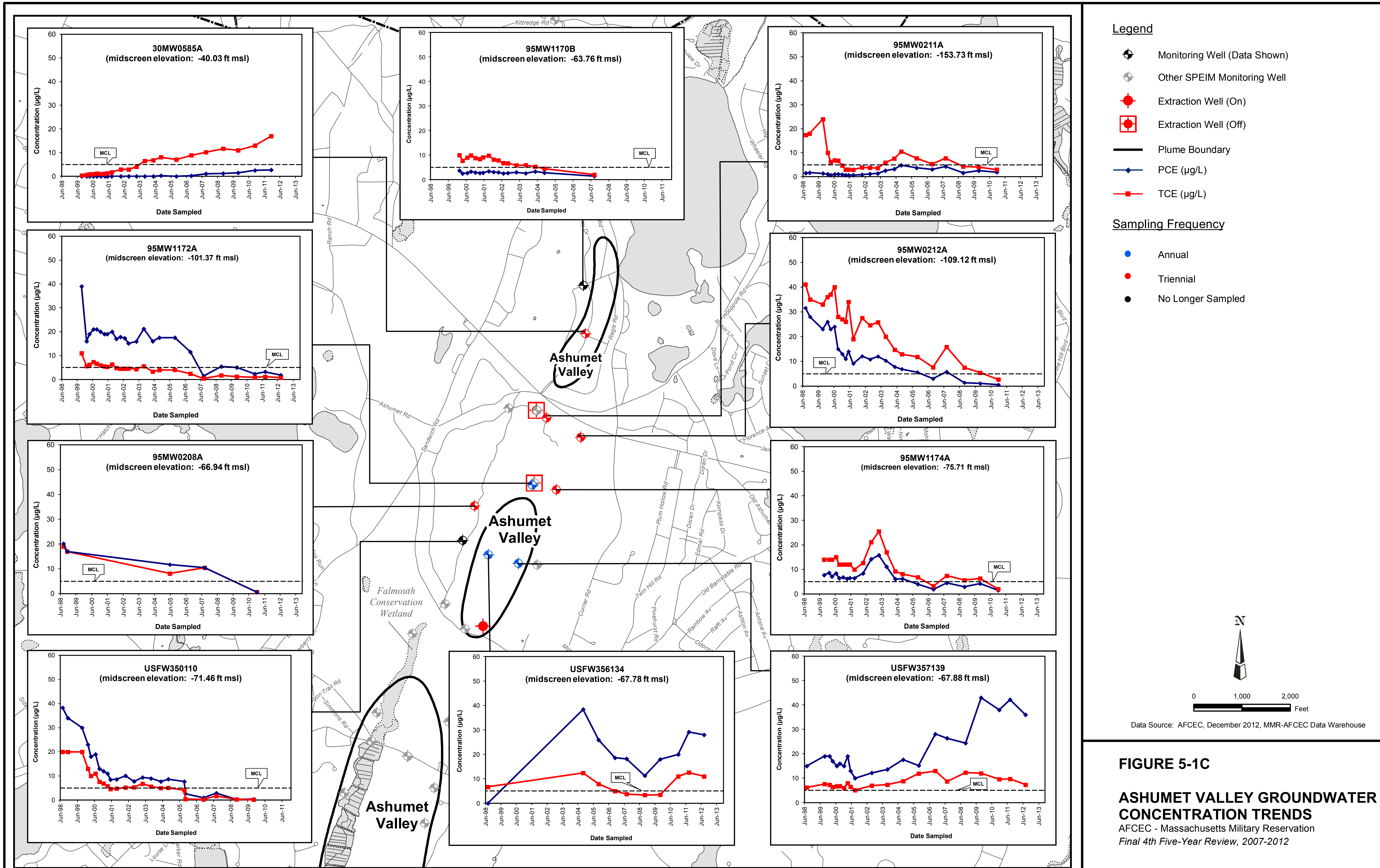
FIGURE 5-1B

ASHUMET VALLEY GROUNDWATER PLUME 2007 AND 2012 COMPARISON

AFCEC - Massachusetts Military Reservation

Final 4th Five-Year Review, 2007-2012

CH2MHILL



Data Source: AFCEC, December 2012, MMR-AFCEC Data Warehouse

FIGURE 5-1C

ASHUMET VALLEY GROUNDWATER CONCENTRATION TRENDS

AFCEC - Massachusetts Military Reservation

Final 4th Five-Year Review, 2007-2012

CH2MHILL.

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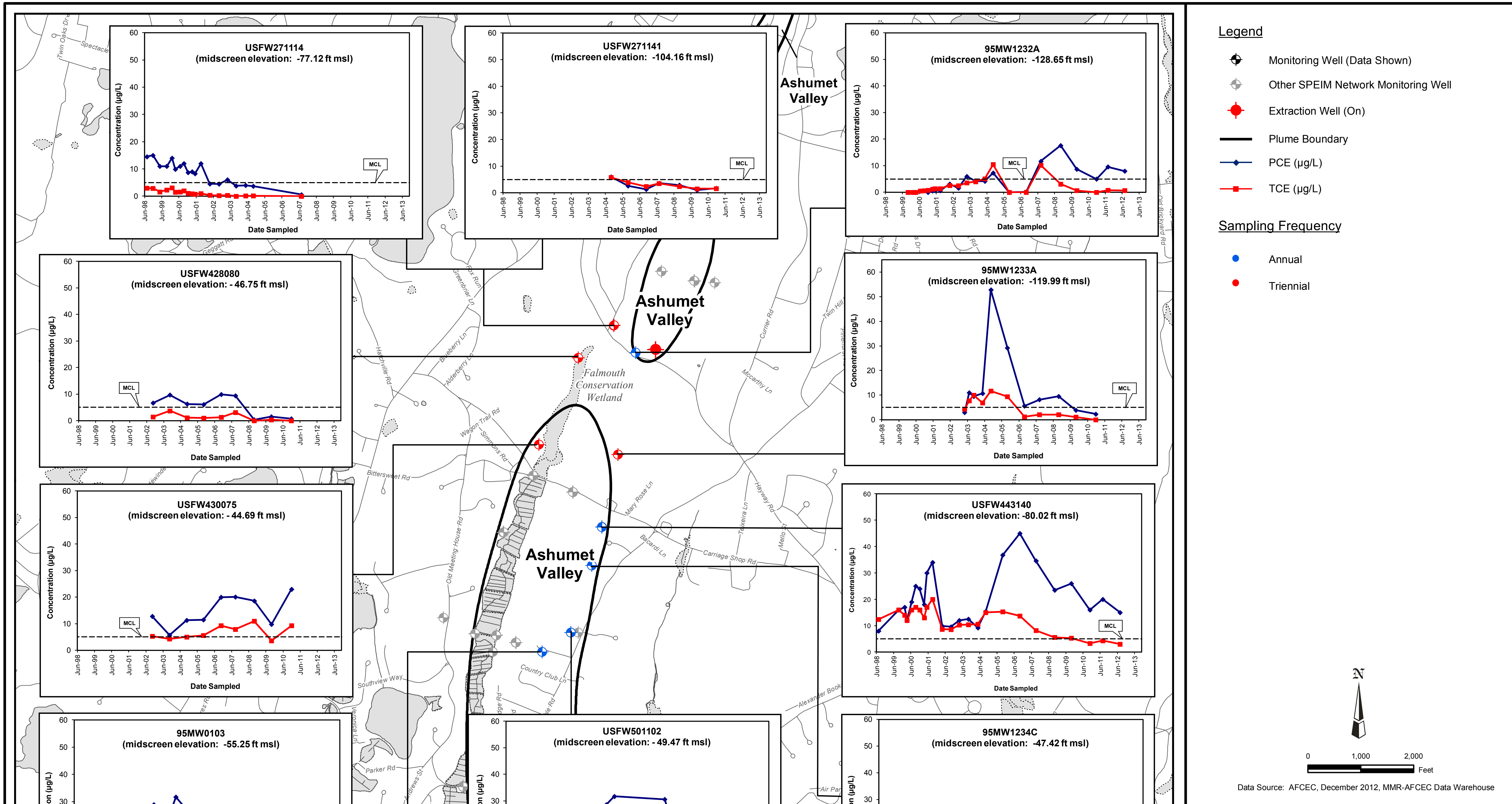

FIGURE 5-1D

ASHUMET VALLEY GROUNDWATER CONCENTRATION TRENDS

AFCEC - Massachusetts Military Reservation

Final 4th Five-Year Review, 2007-2012

CH2MHILL.

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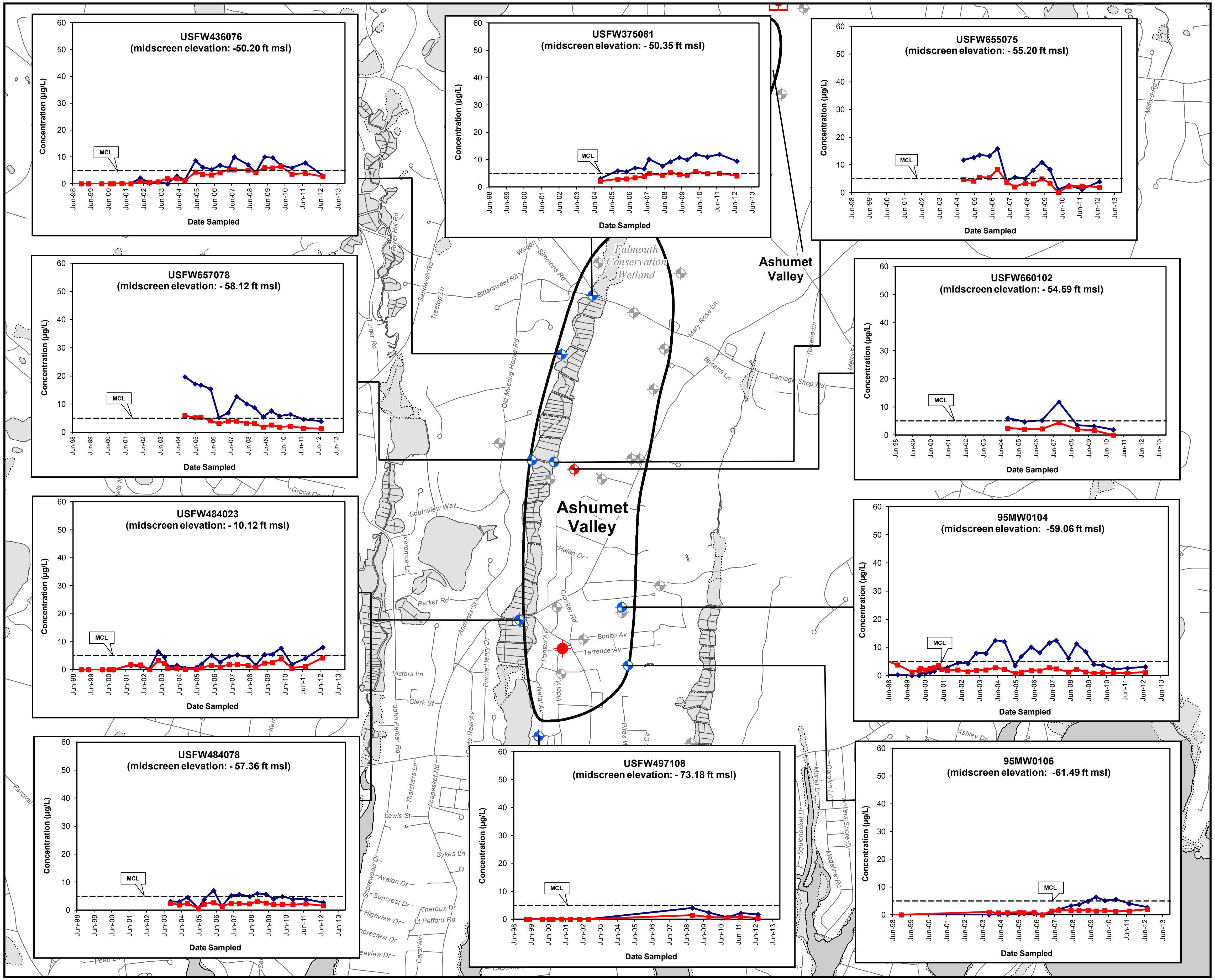

Legend

- Monitoring Well (Data Shown)
- Other SPEIM Network Monitoring Well
- Extraction Well (On)
- Plume Boundary
- PCE (µg/L)
- TCE (µg/L)

Sampling Frequency

- Annual
- Triennial

0 1,000 2,000 Feet

Data Source: AFCEC, December 2012, MMR-AFCEC Data Warehouse

FIGURE 5-1E

ASHUMET VALLEY GROUNDWATER CONCENTRATION TRENDS

AFCEC - Massachusetts Military Reservation

Final 4th Five-Year Review, 2007-2012

CH2MHILL.

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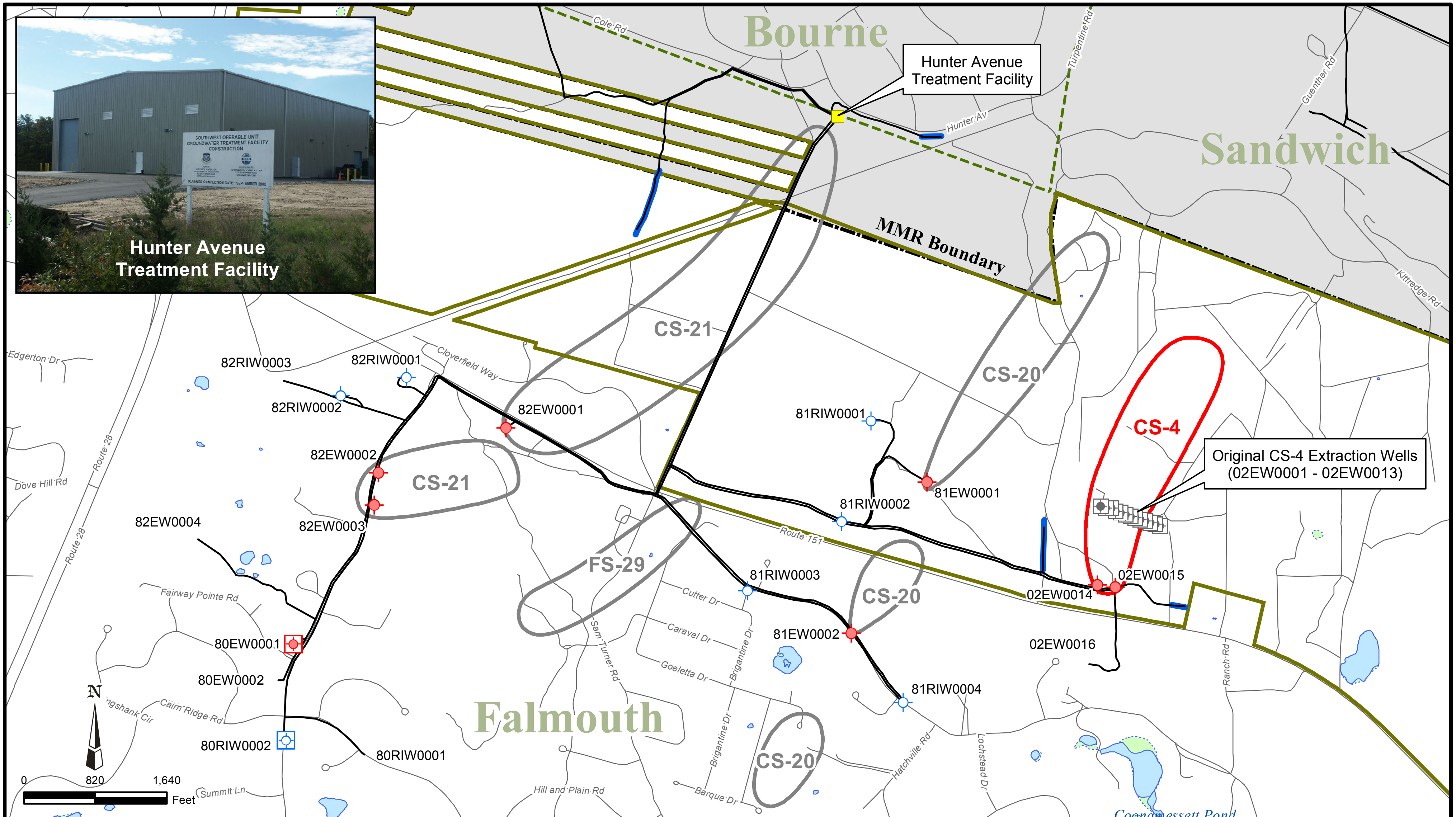

Legend

CS-4 Plume Boundary = Concentrations exceeding drinking water standards. Represents an exceedance of trichloroethene (TCE); tetrachloroethene (PCE); 1,1,2,2-tetrachloroethane (1,1,2,2-TeCA); and/or ethylene dibromide (EDB) (TCE MCL = 5 μg/L); (PCE MCL = 5 μg/L) (1,1,2,2-TeCA GW-1 = 2 μg/L); (EDB MMCL = 0.02 μg/L)

Other Plume Boundary

Massachusetts Military Reservation Boundary

Data Source: AFCEC, February 2013, MMR-AFCEC Data Warehouse
MMR Boundary from Massachusetts Air National Guard 2011

Town Boundary

Infiltration Gallery/Trench

Treatment System Pipeline

Treatment Facility

Bog/Wetland

Crane Wildlife Management Area

Extraction Well (On)

Reinjection Well (On)

Extraction Well (Off)

Reinjection Well (Off)

Extraction Well (Decommissioned)

FIGURE 5-2A

CS-4 GROUNDWATER PLUME AND TREATMENT SYSTEM

AFCEC - Massachusetts Military Reservation

Final 4th Five-Year Review, 2007-2012

CH2MHILL.

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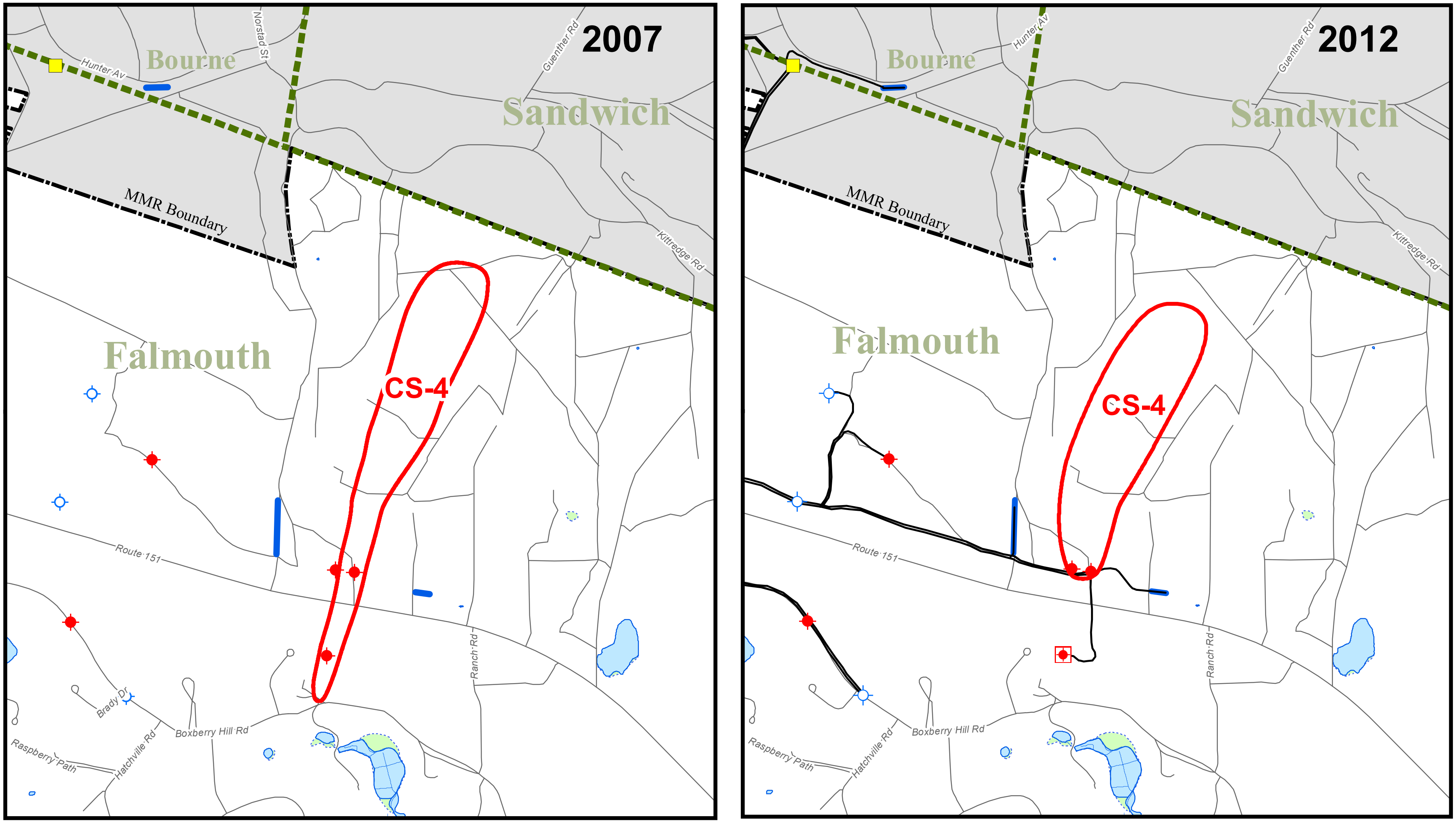

Legend

- Town Boundary
- Massachusetts Military Reservation Boundary
- Plume Boundary
- Bog/Wetland
- Treatment System Pipeline
- Infiltration Trench
- Extraction Well
- Extraction Well (Off)
- Reinjection Well
- Treatment Facility

Data Source: AFCEE, MMR-AFCEE Data Warehouse
MMR Boundary from Massachusetts Air National Guard 2011

N

0 810 1,620 Feet

FIGURE 5-2B

CS-4 GROUNDWATER PLUME 2007 AND 2012 COMPARISON

AFCEE - Massachusetts Military Reservation

Final 4th Five-Year Review, 2007-2012

CH2MHILL

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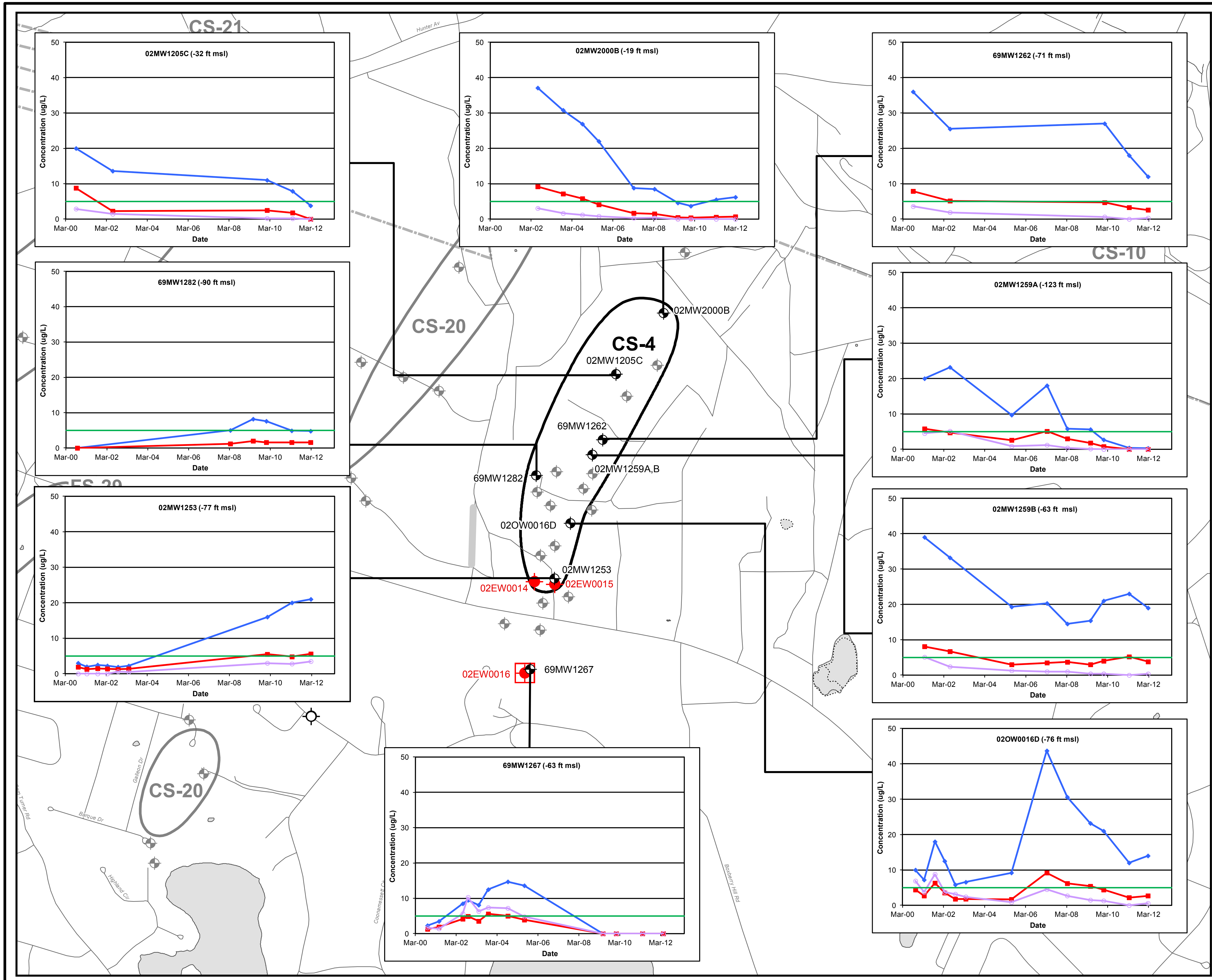

Legend

- Monitoring Well
- Extraction Well (On)
- Extraction Well (Off)
- Operating Reinjection Well
- Massachusetts Military Reservation Boundary
- CS-4 Plume Boundary
- Other Plume Boundary
- Infiltration Trench
- PCE
- TCE
- 1,1,2,2-TeCA
- PCE and TCE MCL (5.0 µg/L)
- ft msl Feet Mean Sea Level

Note: 1,1,2,2-TeCA GW-1 = 2 µg/L

0 510 1,020 Feet

Data Source: AFCEC, August 2012, MMR-AFCEC Data Warehouse
MMR Boundary from Massachusetts Air National Guard 2011

FIGURE 5-2C

CS-4 GROUNDWATER CONCENTRATION TRENDS

AFCEC - Massachusetts Military Reservation

Final 4th Five-Year Review, 2007-2012

CH2MHILL.

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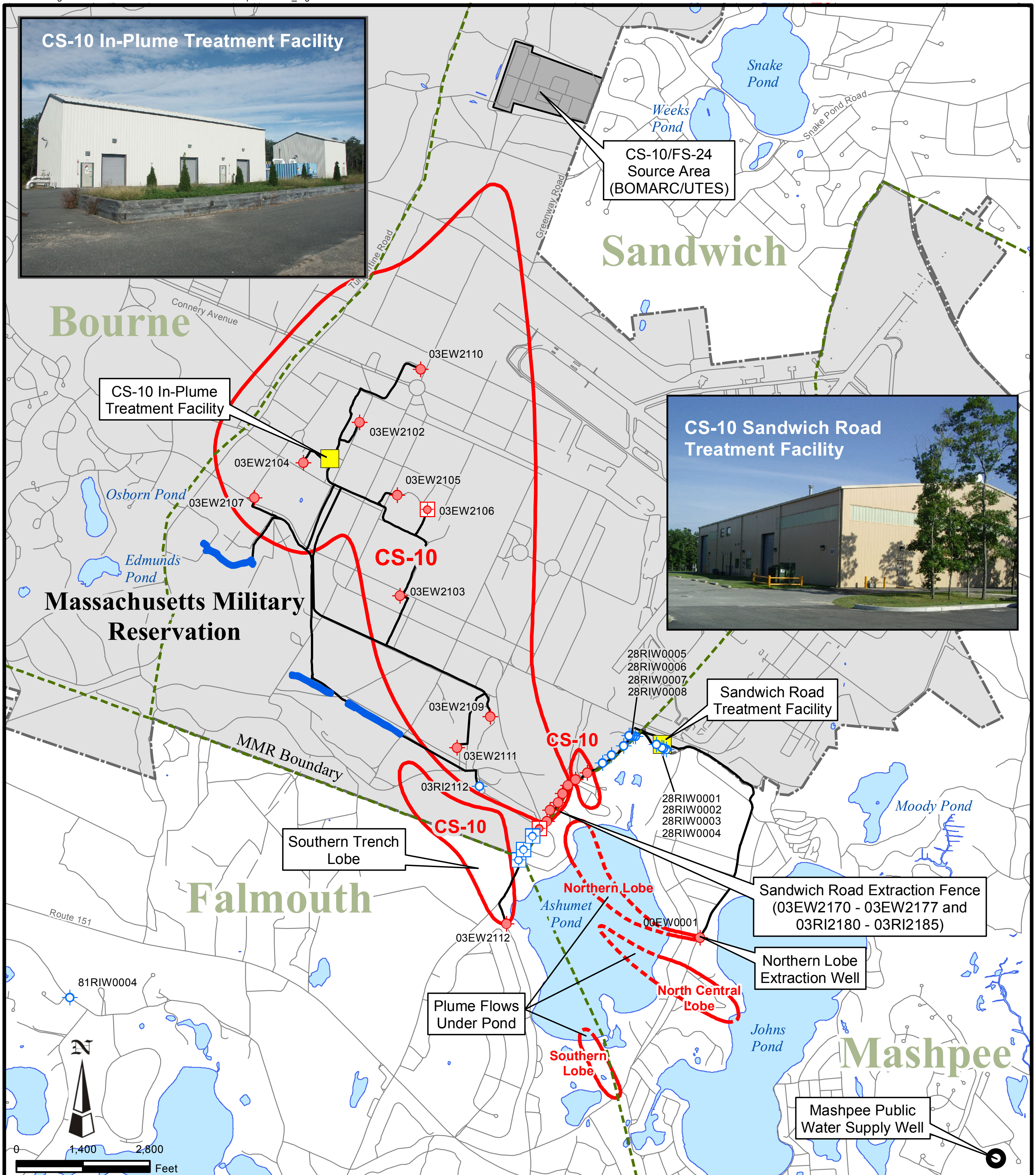

Data Source: AFCEC, April 2013, AFCEC-MMR Data Warehouse

Legend

- CS-10 Plume Boundary = Concentrations exceeding drinking water standards or Maximum Contaminant Level (MCL), dashed where inferred. Represents an exceedance of trichloroethene (TCE) and/or perchloroethene (PCE). (TCE MCL = 5 µg/L) (PCE MCL = 5 µg/L)
- Massachusetts Military Reservation Boundary
- Town Boundary
- Treatment System Piping
- Infiltration Trench
- Public Water Supply Well
- Extraction Well (On)
- Extraction Well (Off)
- Reinjection Well (On)
- Reinjection Well (Off)
- Treatment Facility
- Source Area

FIGURE 5-3A

CS-10 GROUNDWATER PLUME AND TREATMENT SYSTEMS

AFCEC - Massachusetts Military Reservation
Final 4th Five-Year Review, 2007-2012

CH2MHILL

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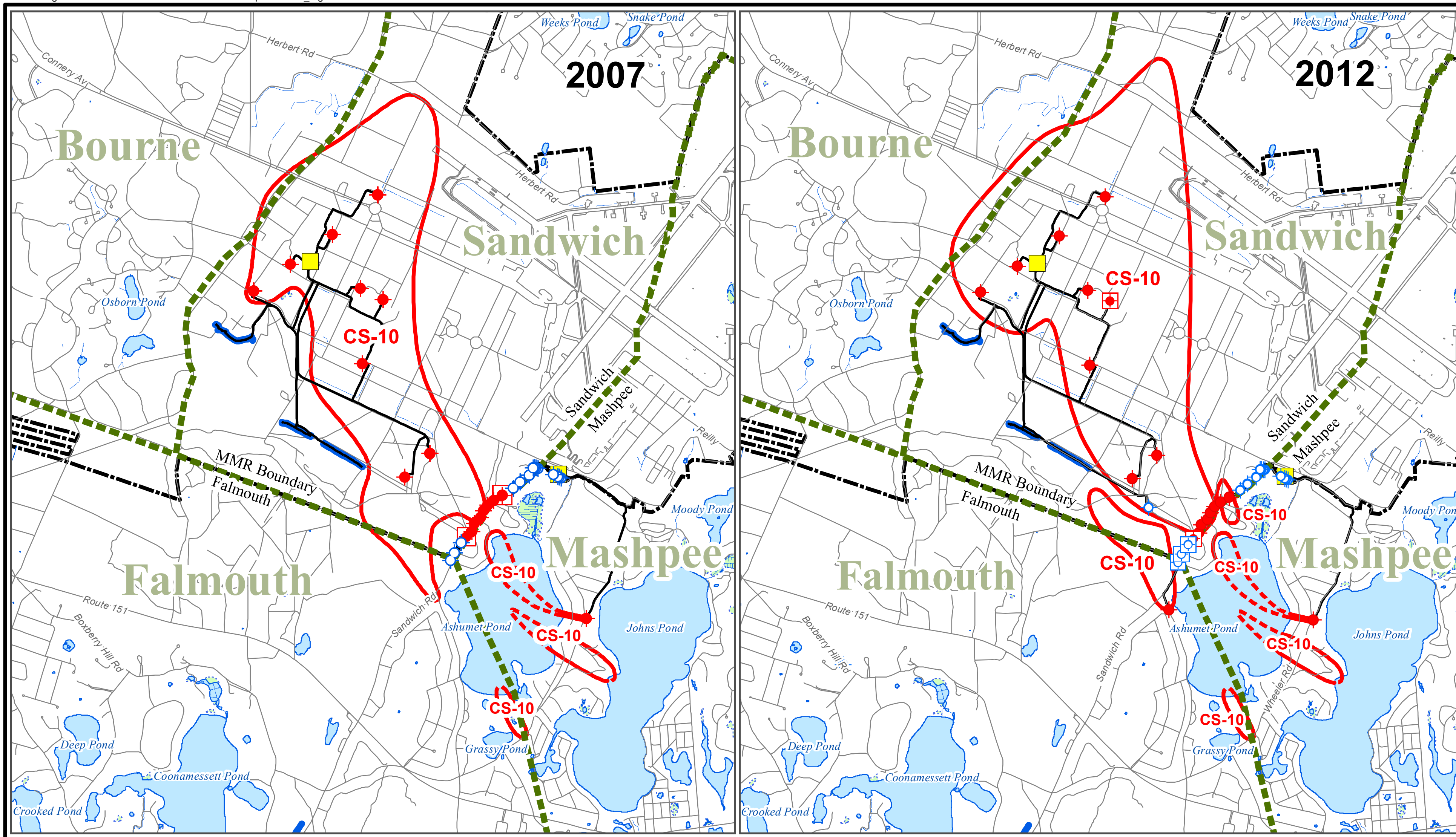


Legend

- Town Boundary
- Massachusetts Military Reservation Boundary
- Plume Boundary (Dashed Where Inferred)
- Bog/Wetland
- Treatment System Pipeline
- Infiltration Trench
- Extraction Well
- Extraction Well (Off)
- Reinjection Well (On)
- Reinjection Well (Off)
- Treatment Facility

Data Source: AFCEC, MMR-AFCEC Data Warehouse
MMR Boundary from Massachusetts Air National Guard 2011

N

0 2,000 4,000 Feet

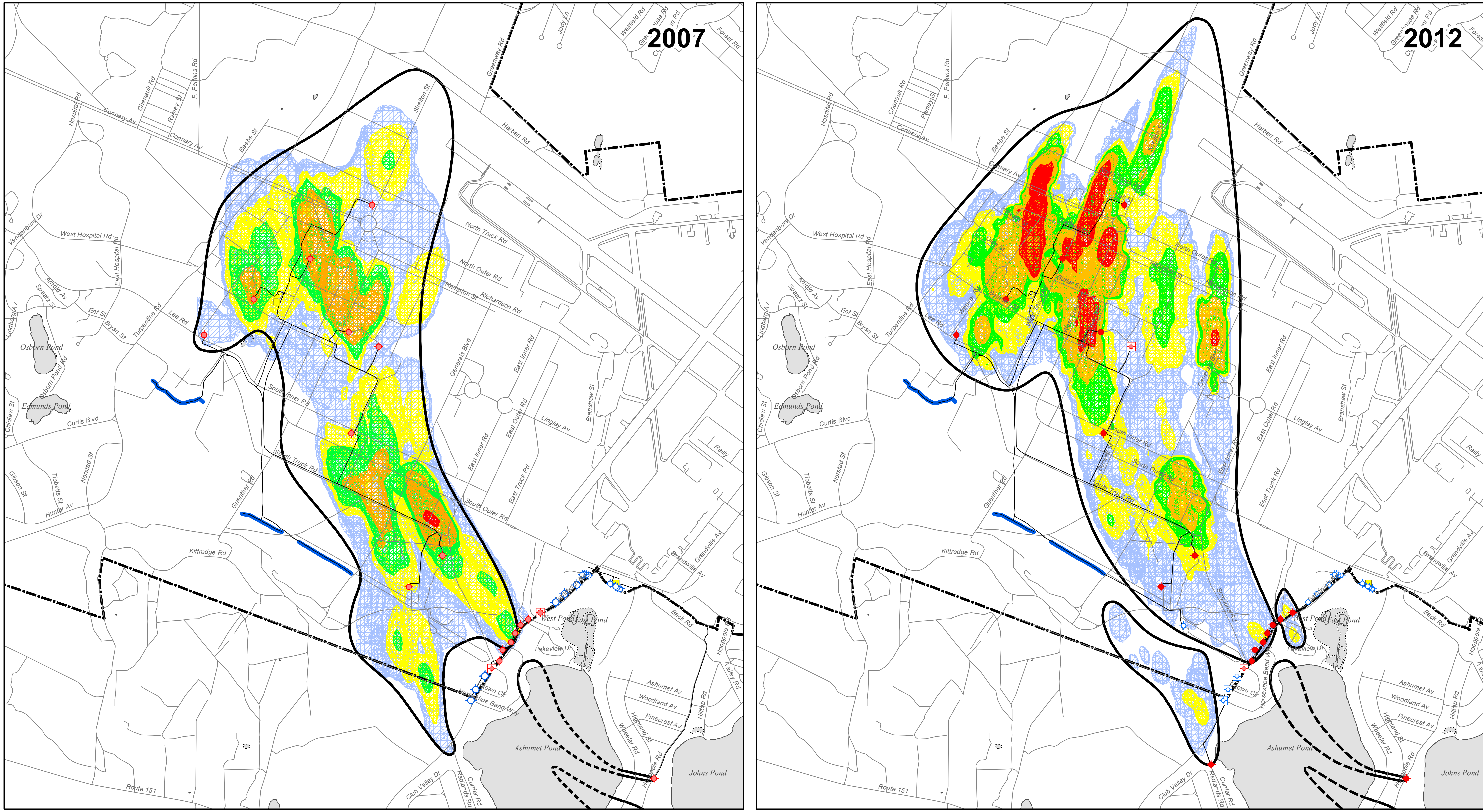
FIGURE 5-3B

CS-10 GROUNDWATER PLUME
2007 AND 2012 COMPARISON

AFCEC - Massachusetts Military Reservation

Final 4th Five-Year Review, 2007-2012

CH2MHILL



Legend

- Massachusetts Military Reservation Boundary
- Plume Boundary (Dashed Where Inferred)
- Infiltration Trench/Gallery
- Treatment System Pipeline
- Bog/Wetland
- Treatment Facility
- Extraction Well (On)
- Reinjection Well (On)
- Extraction Well (Off)
- Reinjection Well (Off)

TCE Plume Shell

- 5 ≤ TCE < 25 μg/L
- 25 ≤ TCE < 50 μg/L
- 50 ≤ TCE < 100 μg/L
- 100 ≤ TCE < 300 μg/L
- TCE ≥ 300 μg/L*

*Maximum TCE concentration in the 2007 TCE plume shell dataset is 450 μg/L at 03MW1024D
Maximum TCE concentration in the 2012 TCE plume shell dataset is 3880 μg/L at 03MW1069A

Data Source: AFCEC, MMR-AFCEC Data Warehouse
MMR Boundary from Massachusetts Air National Guard 2011

N

0 1,000 2,000 Feet

FIGURE 5-3C

CS-10 GROUNDWATER PLUME 2007 AND 2012 PLUME SHELLS

AFCEE - Massachusetts Military Reservation

Final 4th Five-Year Review, 2007-2012

CH2MHILL.

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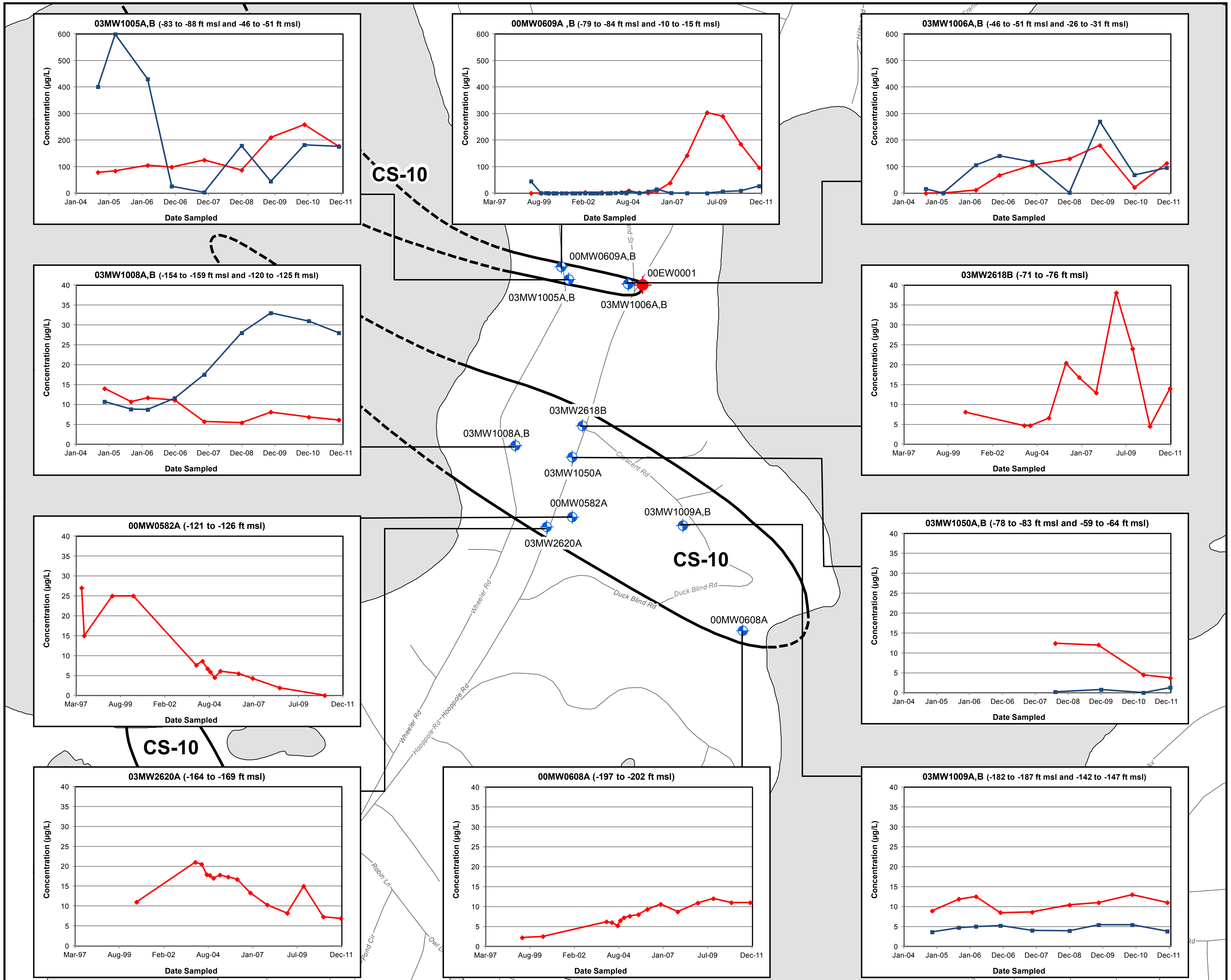
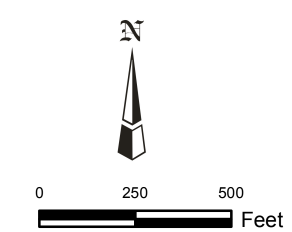


Legend

- Monitoring Well
- Extraction Well
- Massachusetts Military Reservation Boundary
- Plume Boundary (Dashed Where Inferred)
- TCE
- TCE for Shallow (B Screen) Well Where Two Trend Lines are Presented



Data Source: AFCEC, January 2013, MMR-AFCEC Data Warehouse
MMR boundary from Massachusetts Air National Guard 2011

Figure (with revisions) presented at the 26 April 2012 Technical Update Meeting and will be included in the CS-10 2012 SLR

FIGURE 5-3D

CS-10 GROUNDWATER CONCENTRATION TRENDS

AFCEC - Massachusetts Military Reservation

Final 4th Five-Year Review, 2007-2012

CH2MHILL.

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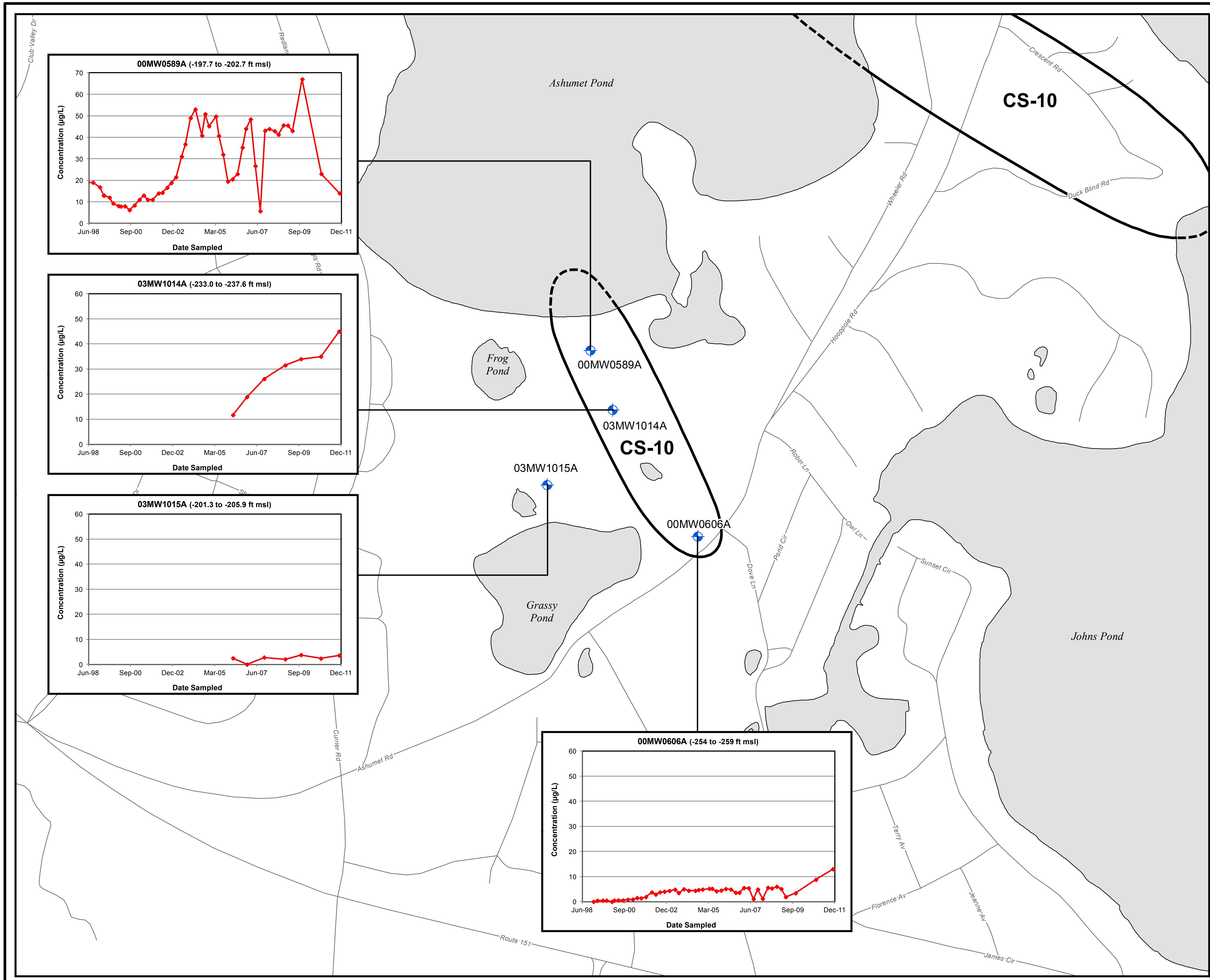

Data Source: AFCEC, January 2013, MMR-AFCEC Data Warehouse

FIGURE 5-3E

CS-10 GROUNDWATER CONCENTRATION TRENDS

AFCEC - Massachusetts Military Reservation

Final 4th Five-Year Review, 2007-2012

CH2MHILL.

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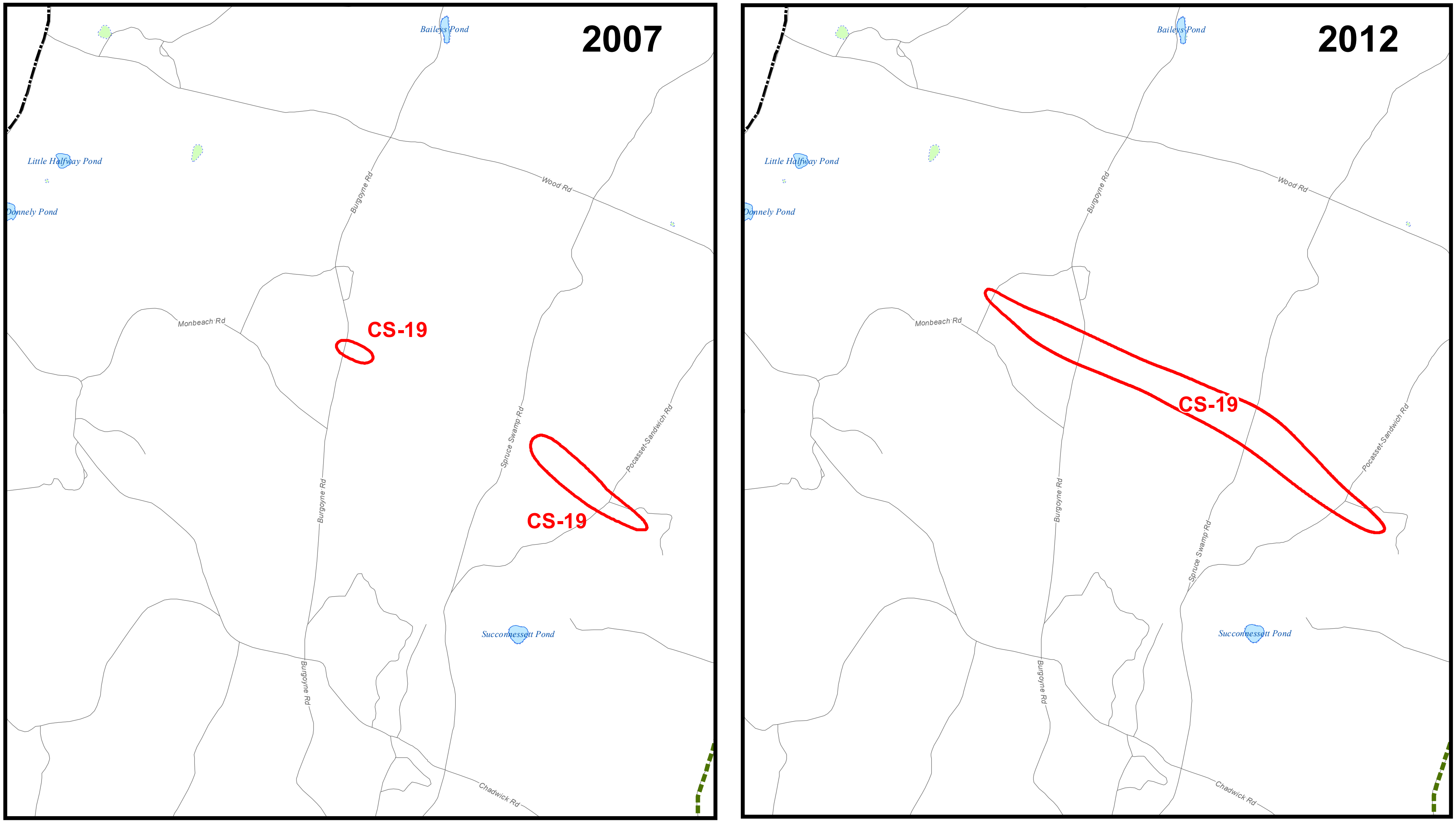

Legend

- Town Boundary
- Massachusetts Military Reservation Boundary
- Plume Boundary
- Bog/Wetland

Data Source: AFCEE, MMR-AFCEE Data Warehouse
MMR Boundary from Massachusetts Air National Guard 2011

N

0 1,100 2,200 Feet

FIGURE 5-4A

CS-19 GROUNDWATER PLUME 2007 AND 2012 COMPARISON

AFCEE - Massachusetts Military Reservation

Final 4th Five-Year Review, 2007-2012

CH2MHILL

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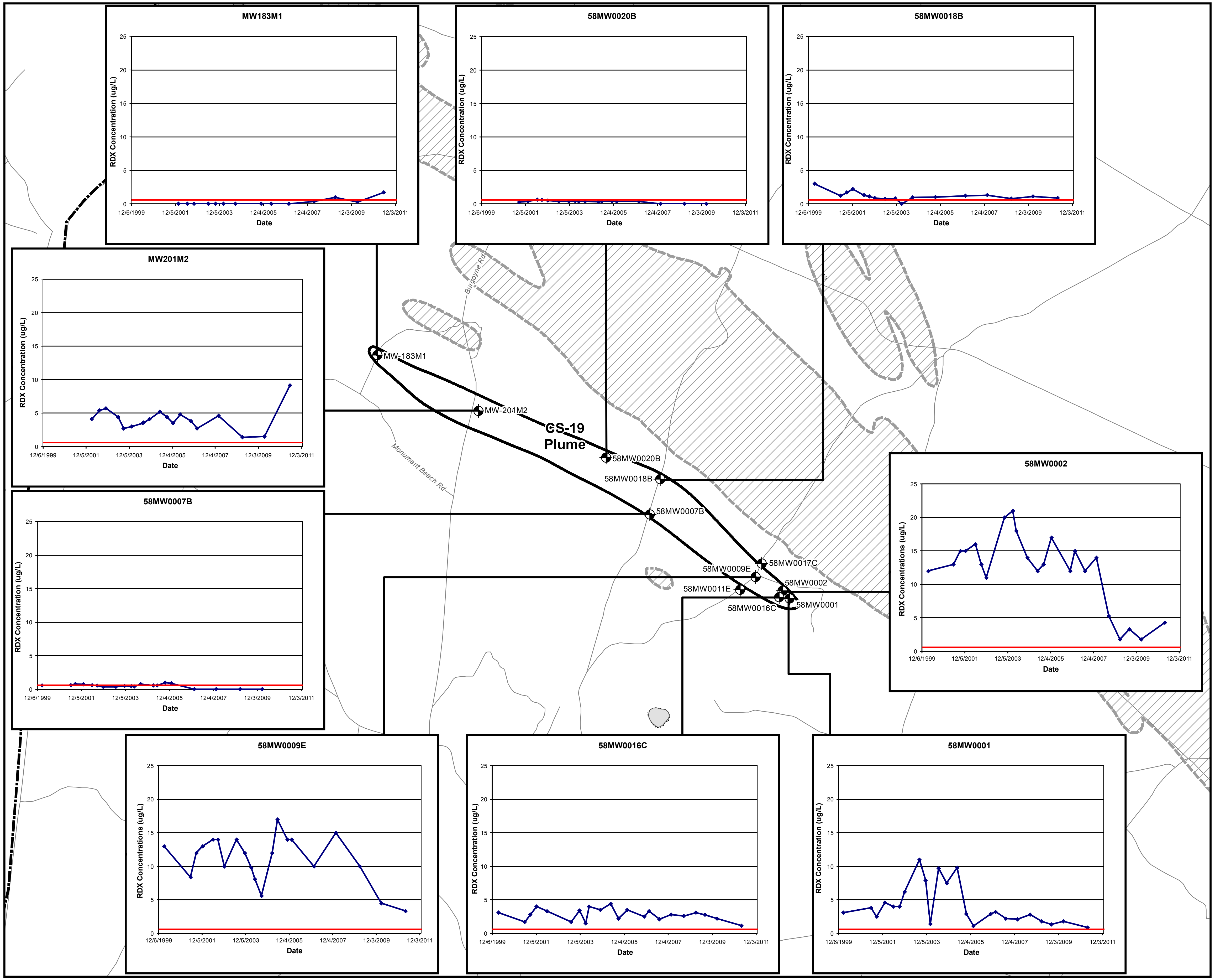

Legend

- CS-19 Monitoring Well
- Massachusetts Military Reservation Boundary
- Plume Boundary
- Central Impact Area RDX and Perchlorate Plume
- EPA Risk-based Level (0.6 µg/L)
- RDX Data

N

0 740 1,480 Feet

Data Source: AFCEC, June 2012, MMR-AFCEC Data Warehouse
Impact Area Plume provided by IAGWSP, July 2011

FIGURE 5-4B

CS-19 GROUNDWATER CONCENTRATION TRENDS

AFCEC - Massachusetts Military Reservation

Final 4th Five-Year Review, 2007-2012

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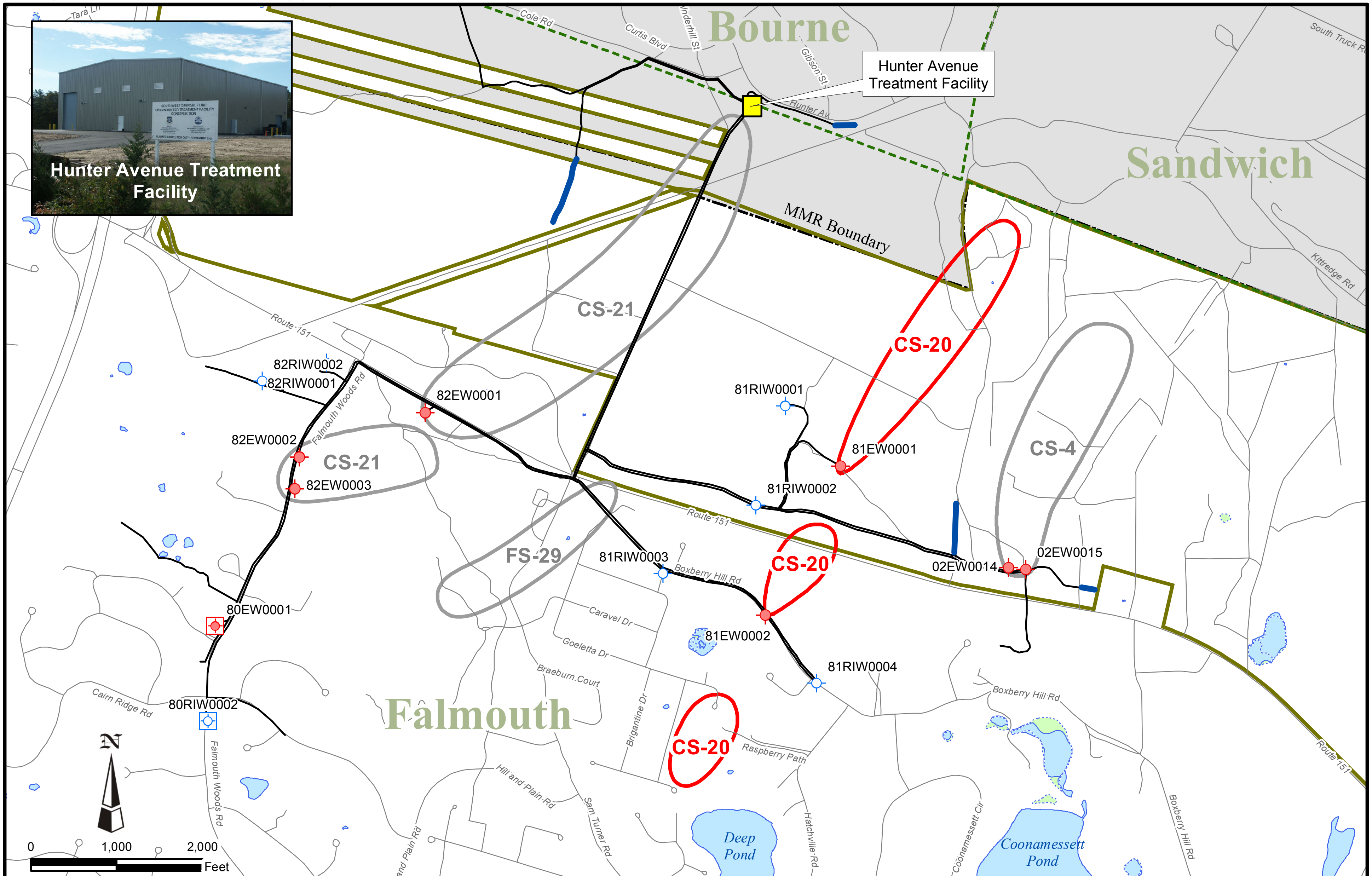

Legend

- CS-20 Plume Boundary = Concentrations exceeding drinking water standards. Represents an exceedance of tetrachloroethene (PCE); (PCE MCL = 5 µg/L)
- Other Plume Boundary
- Massachusetts Military Reservation Boundary
- Town Boundary
- Infiltration Gallery/Trench
- Treatment System Pipeline
- Treatment Facility
- Bog/Wetland
- Crane Wildlife Management Area
- Extraction Well (On)
- Extraction Well (Off)
- Reinjection Well (On)
- Reinjection Well (Off)

Data Source: AFCEC, February 2013, AFCEC-MMR Data Warehouse
MMR Boundary from Massachusetts Air National Guard 2011

FIGURE 5-5A

CS-20 GROUNDWATER PLUME AND TREATMENT SYSTEM

AFCEC - Massachusetts Military Reservation

Final 4th Five-Year Review, 2007-2012

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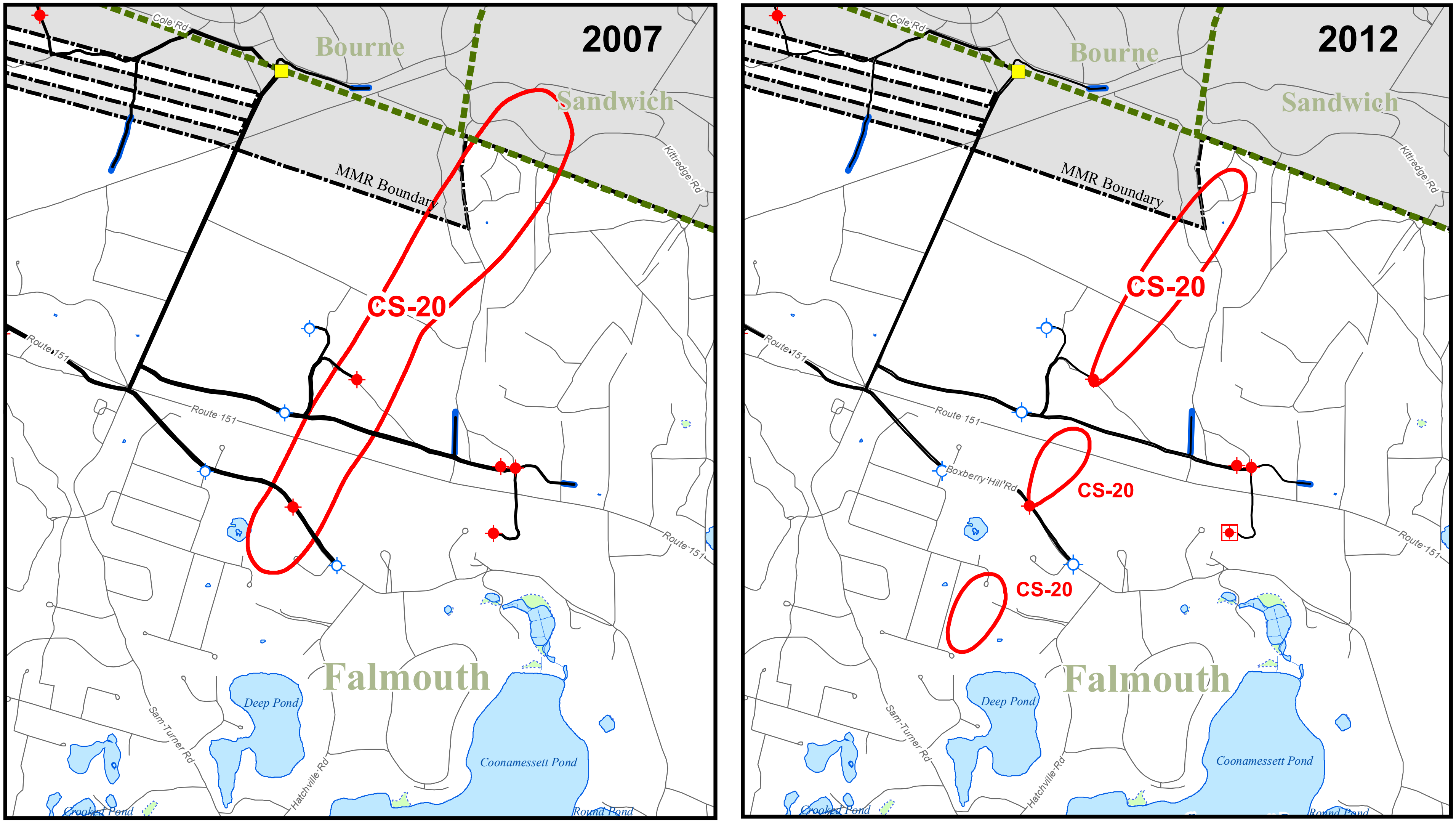

Legend

- Town Boundary
- Massachusetts Military Reservation Boundary
- Plume Boundary
- Bog/Wetland
- Treatment System Pipeline
- Infiltration Trench
- Extraction Well
- Extraction Well (Off)
- Reinjection Well
- Treatment Facility

Data Source: AFCEE, MMR-AFCEE Data Warehouse
MMR Boundary from Massachusetts Air National Guard 2011

N

0 1,000 2,000 Feet

FIGURE 5-5B

CS-20 GROUNDWATER PLUME 2007 AND 2012 COMPARISON

AFCEE - Massachusetts Military Reservation

Final 4th Five-Year Review, 2007-2012

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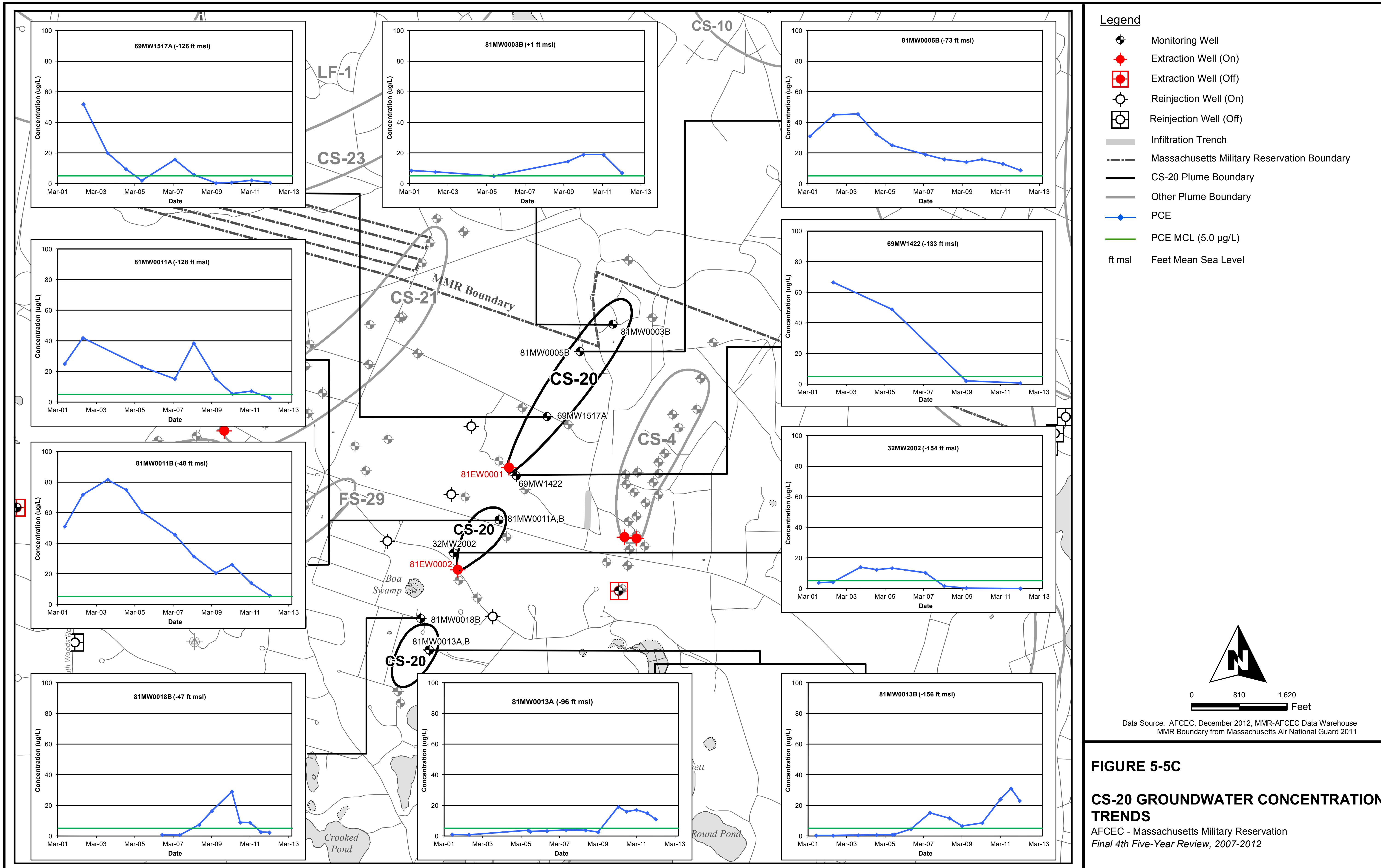


Data Source: AFCEC, December 2012, MMR-AFCEC Data Warehouse
MMR Boundary from Massachusetts Air National Guard 2011

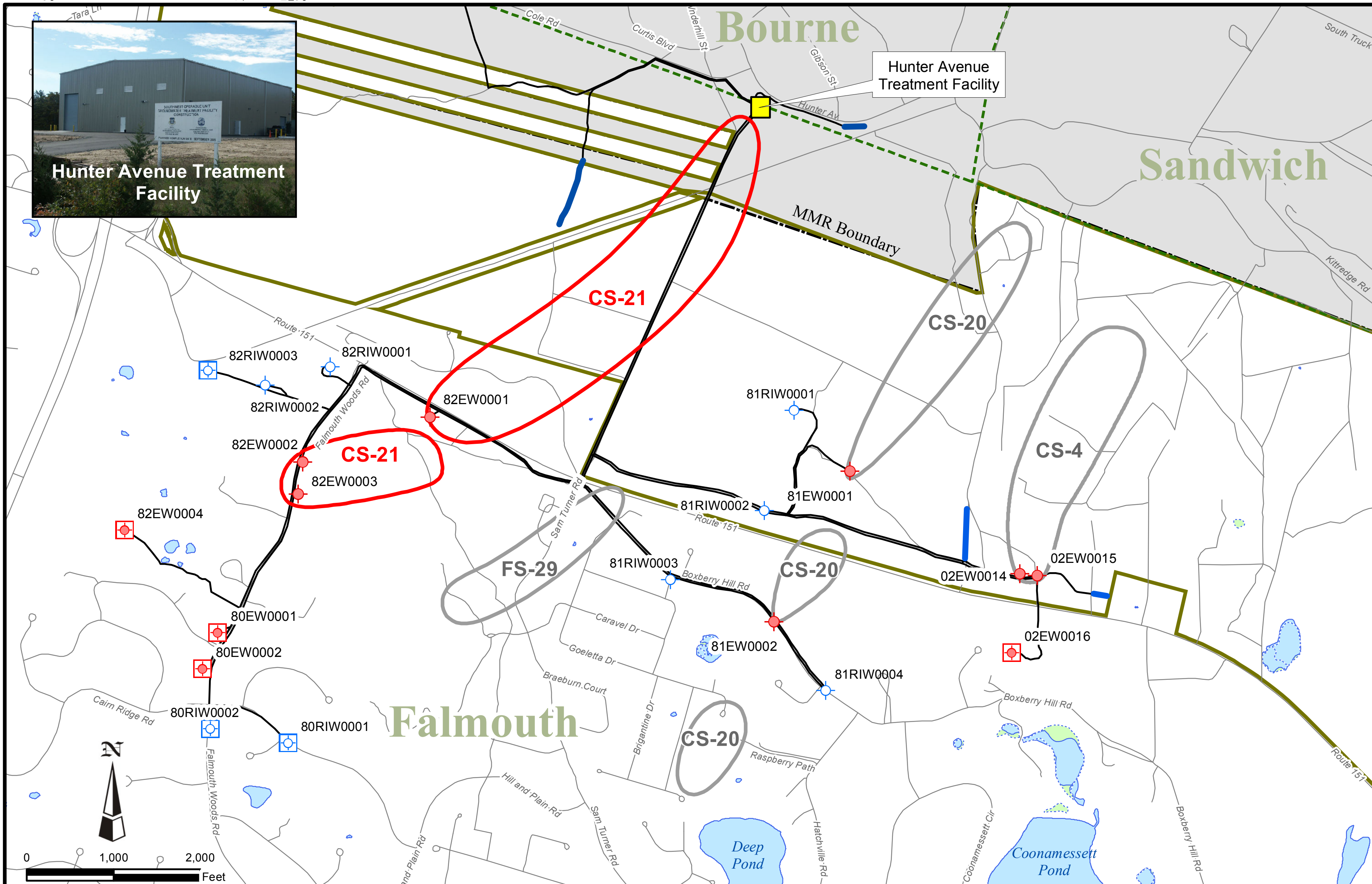
FIGURE 5-5C

CS-20 GROUNDWATER CONCENTRATION TRENDS

AFCEC - Massachusetts Military Reservation

Final 4th Five-Year Review, 2007-2012

CH2MHILL.



Legend

CS-21 Plume Boundary = Concentrations exceeding drinking water standards. Represents an exceedance of tetrachloroethene (TCE); (TCE MCL = 5 µg/L)	
Other Plume Boundary	
Massachusetts Military Reservation Boundary	
Town Boundary	
Infiltration Gallery/Trench	Extraction Well (On)
Treatment System Pipeline	Extraction Well (Off)
Treatment Facility	Reinjection Well (On)
Bog/Wetland	Reinjection Well (Off)
Crane Wildlife Management Area	

Data Source: AFCEC, February 2013, AFCEC-MMR Data Warehouse
MMR Boundary from Massachusetts Air National Guard 2011

FIGURE 5-6A

CS-21 GROUNDWATER PLUME AND TREATMENT SYSTEM

AFCEC - Massachusetts Military Reservation

Final 4th Five-Year Review, 2007-2012

CH2MHILL

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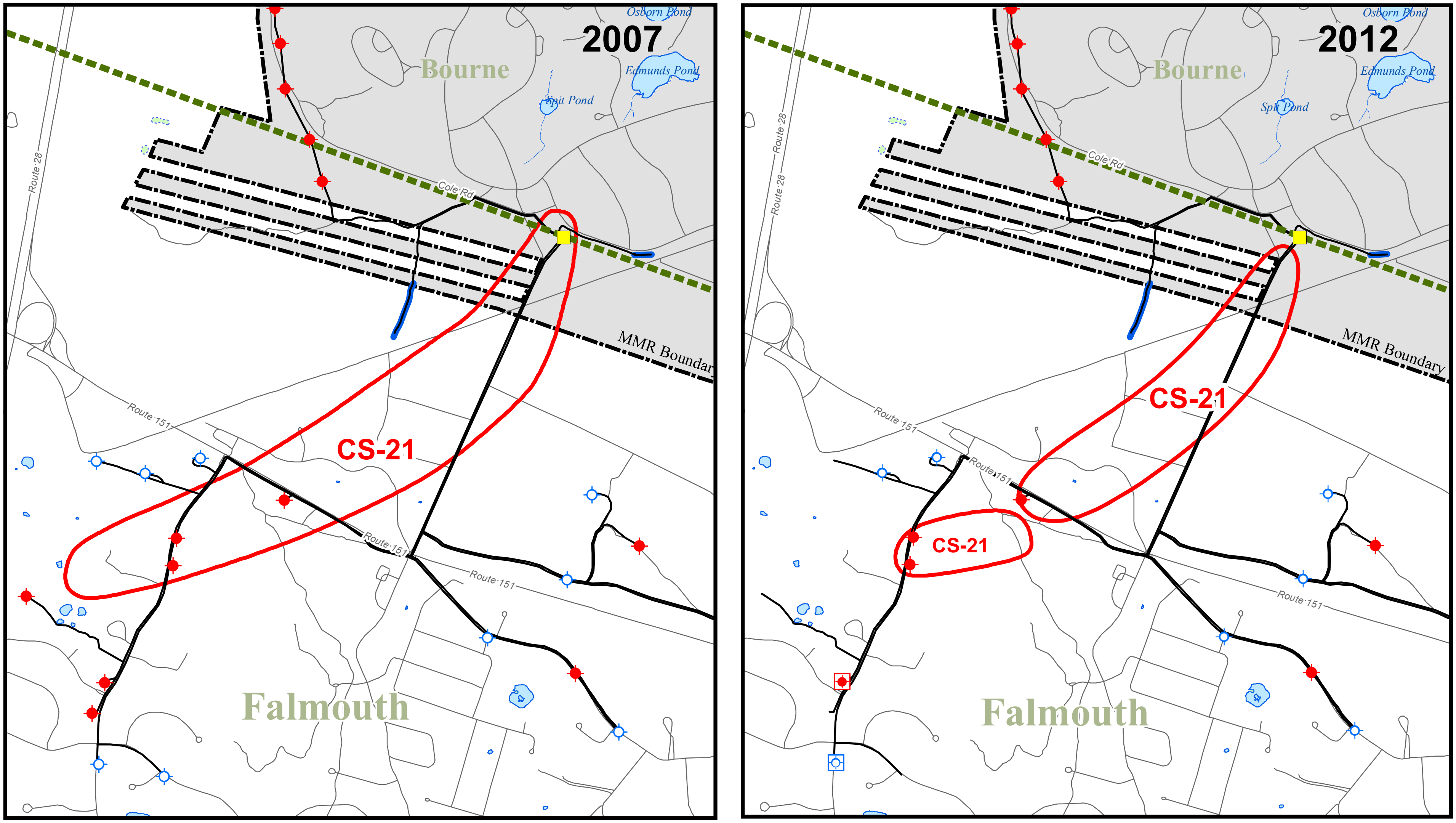

Legend

- Town Boundary
- Massachusetts Military Reservation Boundary
- Plume Boundary
- Bog/Wetland
- Treatment System Pipeline
- Infiltration Trench
- Extraction Well
- Extraction Well (Off)
- Reinjection Well
- Reinjection Well (Off)
- Treatment Facility

Data Source: AFCEE, MMR-AFCEE Data Warehouse
MMR Boundary from Massachusetts Air National Guard 2011

N

0 1,000 2,000 Feet

FIGURE 5-6B

CS-21 GROUNDWATER PLUME 2007 AND 2012 COMPARISON

AFCEE - Massachusetts Military Reservation

Final 4th Five-Year Review, 2007-2012

CH2MHILL

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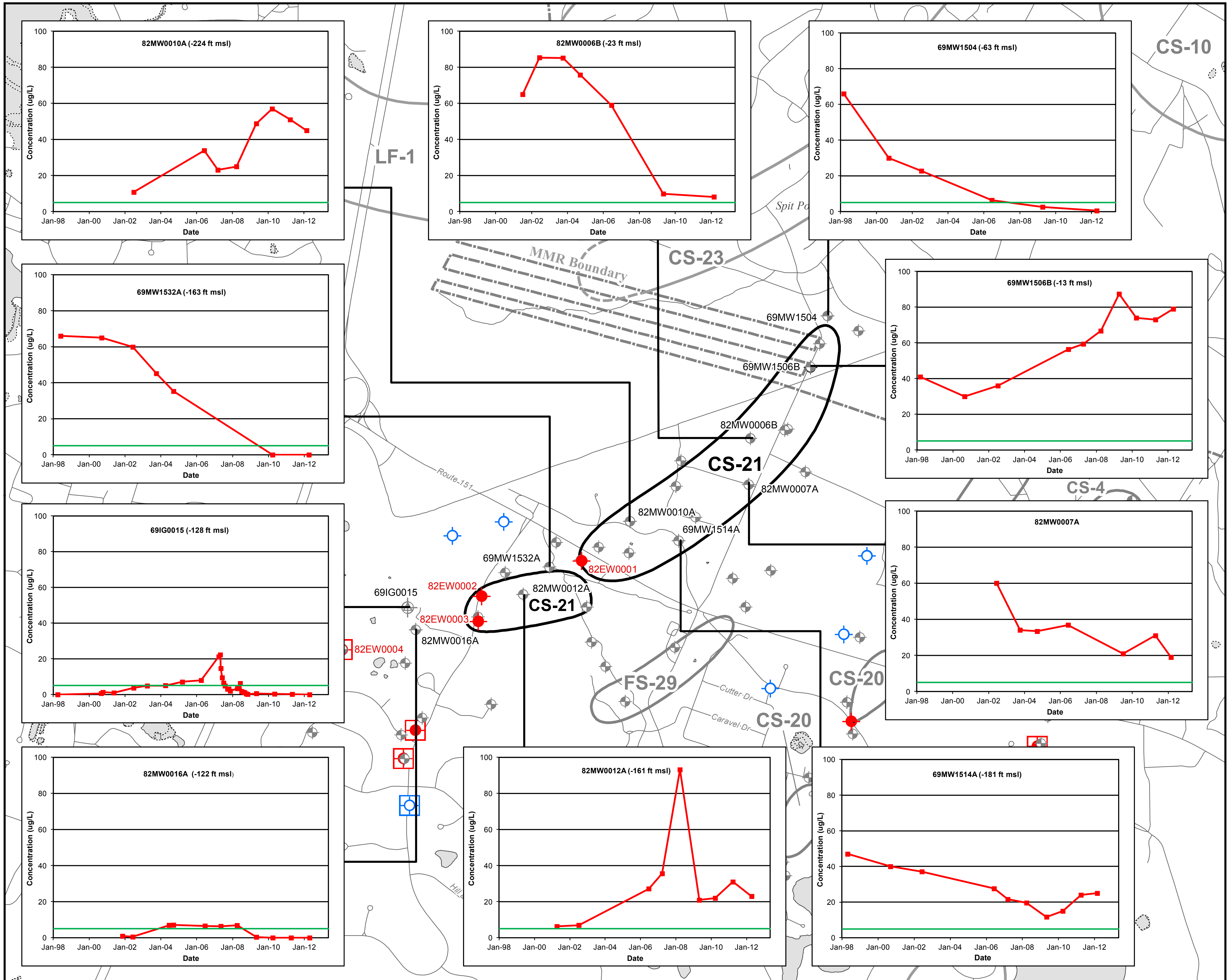

Legend

- Monitoring Well
- Extraction Well (On)
- Extraction Well (Off)
- Reinjection Well (On)
- Reinjection Well (Off)
- Irrigation Well
- Massachusetts Military Reservation Boundary
- CS-21 Plume Boundary
- Other Plume Boundary
- TCE
- TCE MCL (5.0 µg/L)
- ft msl Feet Mean Sea Level

N

0 890 1,780 Feet

Data Source: AFCEC, January 2013, MMR-AFCEC Data Warehouse
MMR Boundary from Massachusetts Air National Guard 2011

FIGURE 5-6C

CS-21 GROUNDWATER CONCENTRATION TRENDS

AFCEC - Massachusetts Military Reservation
Final 4th Five-Year Review, 2007-2012

CH2MHILL.

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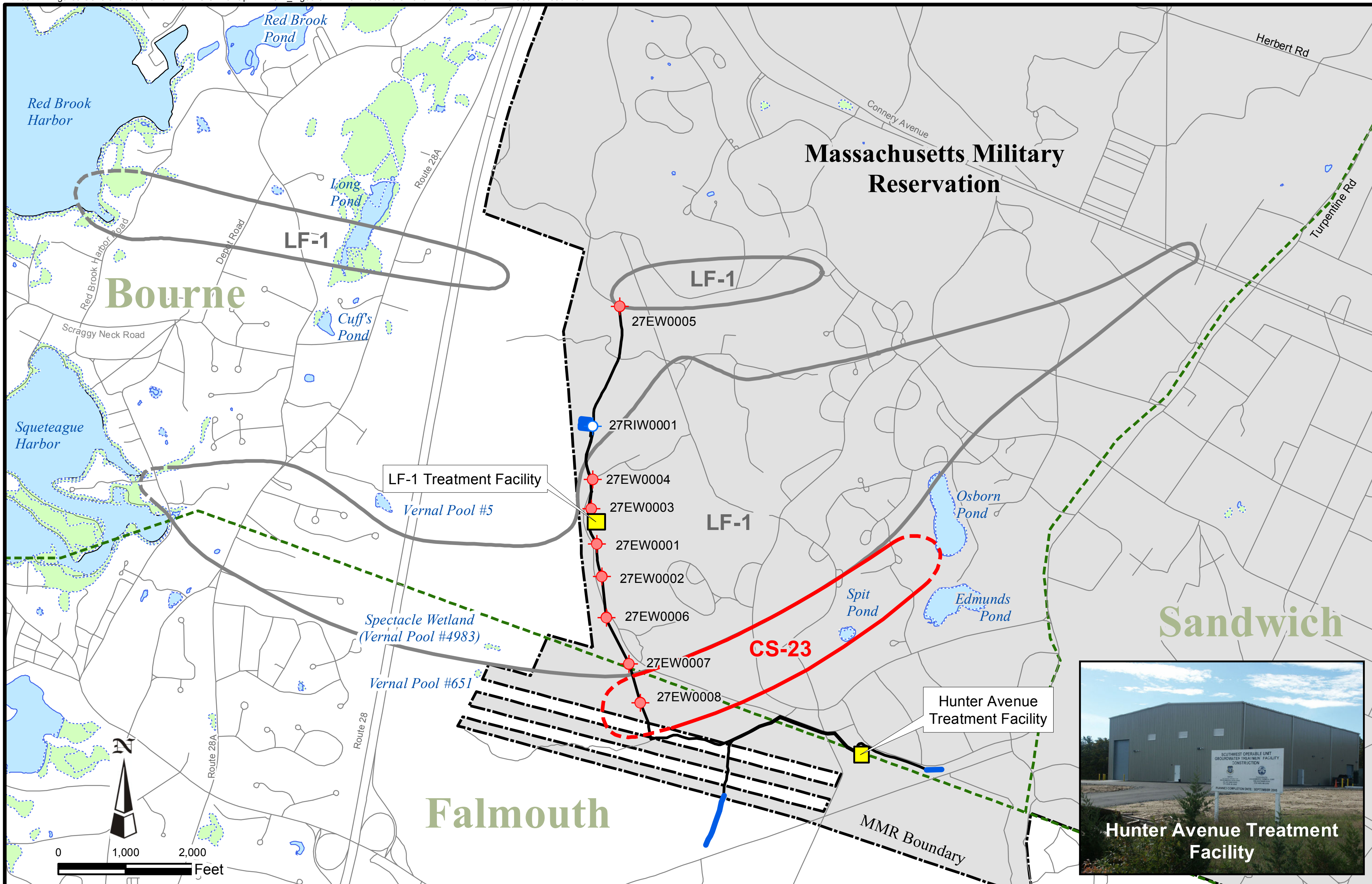

Data Source: AFCEC, February 2013, AFCEC-MMR Data Warehouse

Legend

- CS-23 Plume Boundary = Concentrations exceeding drinking water standards or Maximum Contaminant Level (MCL). (Dashed where inferred.) Represents an exceedance of: Trichloroethene (TCE): MCL = 5 µg/L; Carbon Tetrachloride (CCl_4): MCL = 5 µg/L
- Other Plume Boundary (Dashed Where Inferred)
- Massachusetts Military Reservation Boundary
- Town Boundary
- Infiltration Gallery/Trench
- Treatment Facility
- Bog/Wetland
- Extraction Well
- Reinjection Well

FIGURE 5-7A

CS-23 GROUNDWATER PLUME AND TREATMENT SYSTEM

AFCEC - Massachusetts Military Reservation

Final 4th Five-Year Review, 2007-2012

CH2MHILL.

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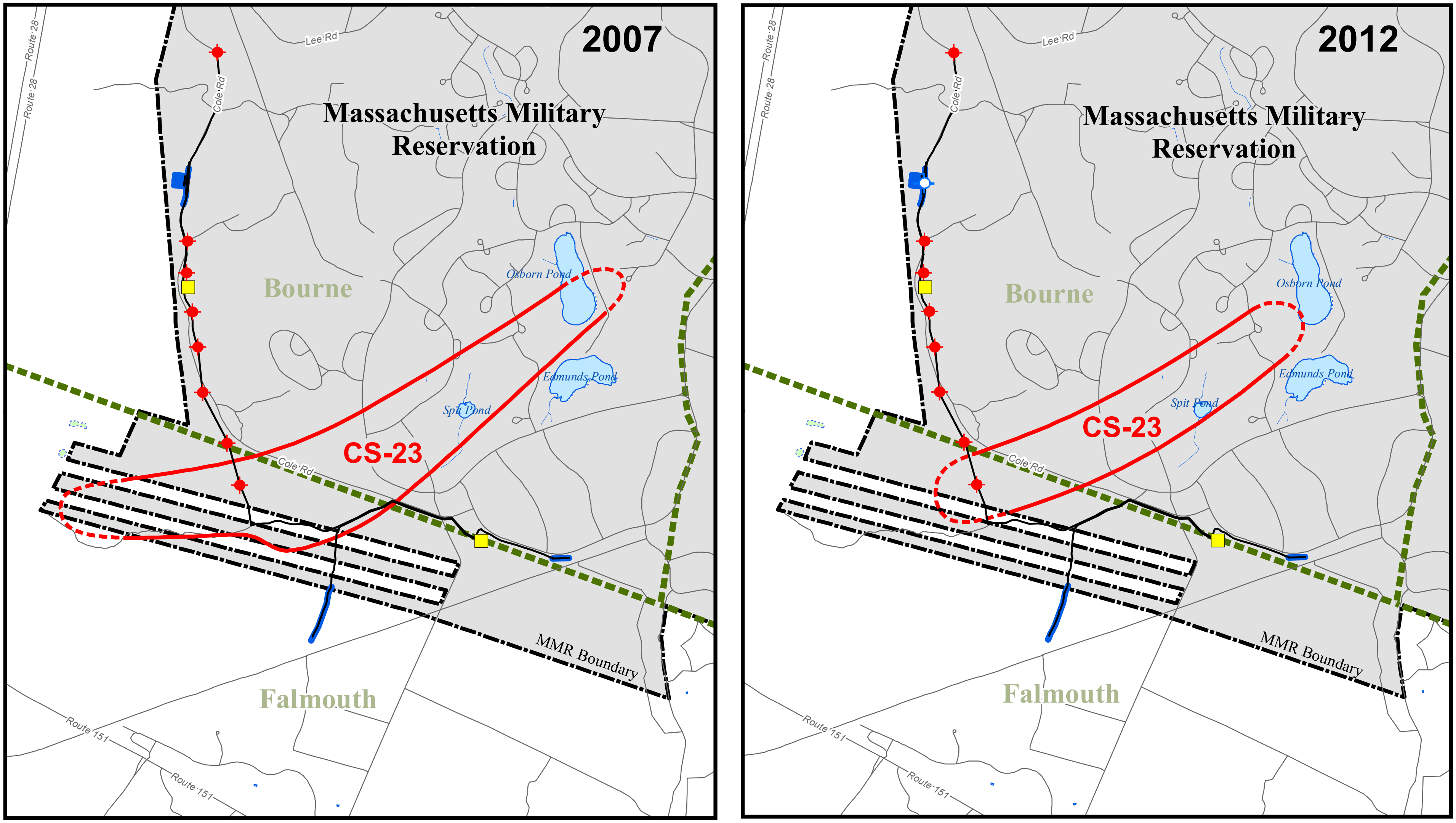

Legend

- Town Boundary
- Massachusetts Military Reservation Boundary
- Plume Boundary (Dashed Where Inferred)
- Treatment System Pipeline
- Infiltration Trench
- Extraction Well
- Reinjection Well
- Treatment Facility
- Bog/Wetland

Data Source: AFCEE, MMR-AFCEE Data Warehouse
MMR Boundary from Massachusetts Air National Guard 2011

N

0 1,000 2,000 Feet

FIGURE 5-7B

CS-23 GROUNDWATER PLUME 2007 AND 2012 COMPARISON

AFCEE - Massachusetts Military Reservation

Final 4th Five-Year Review, 2007-2012

CH2MHILL

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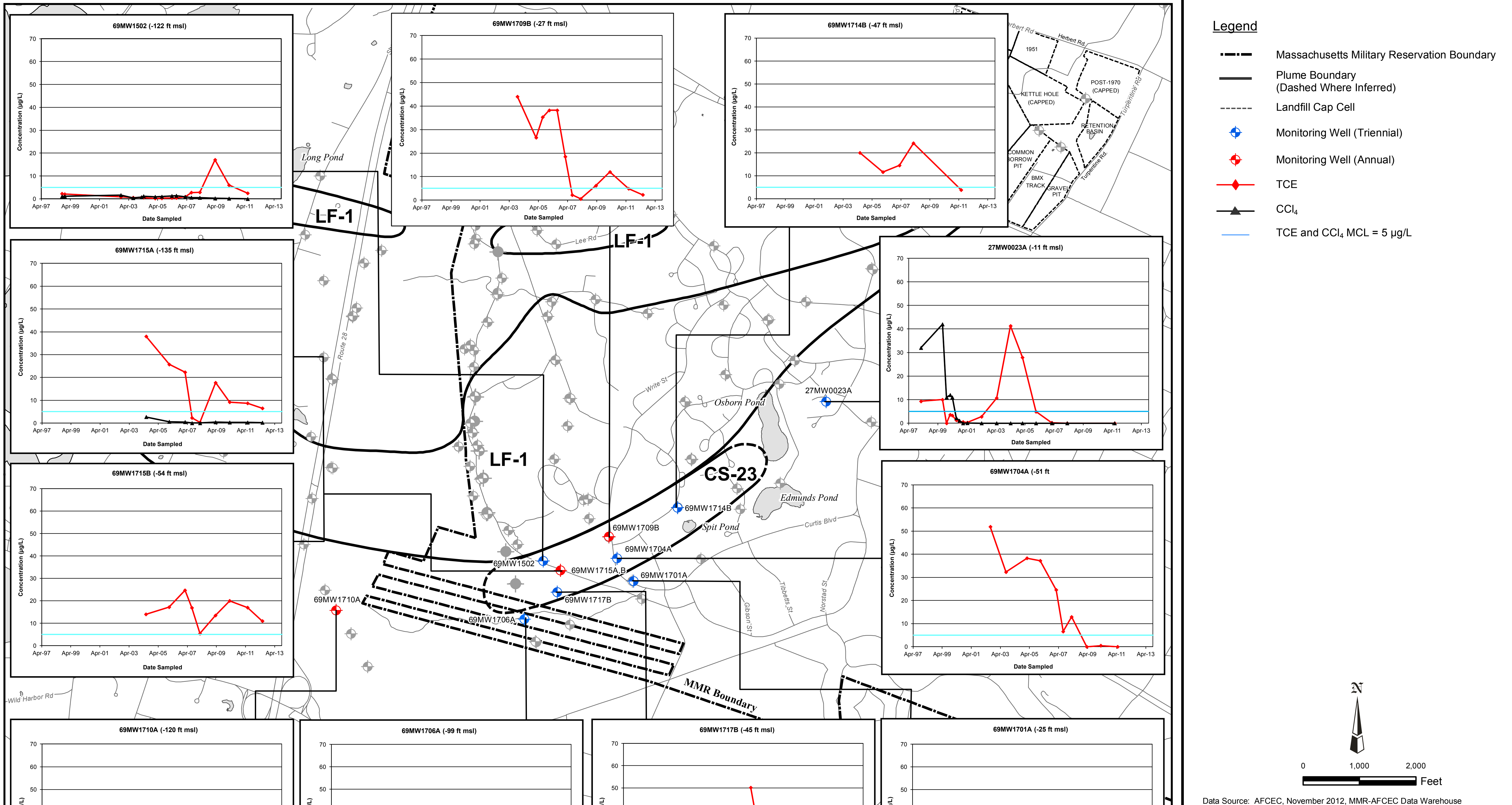

Data Source: AFCEC, November 2012, MMR-AFCEC Data Warehouse

FIGURE 5-7C

CS-23 GROUNDWATER CONCENTRATION TRENDS

AFCEC - Massachusetts Military Reservation

Final 4th Five-Year Review, 2007-2012

CH2MHILL.

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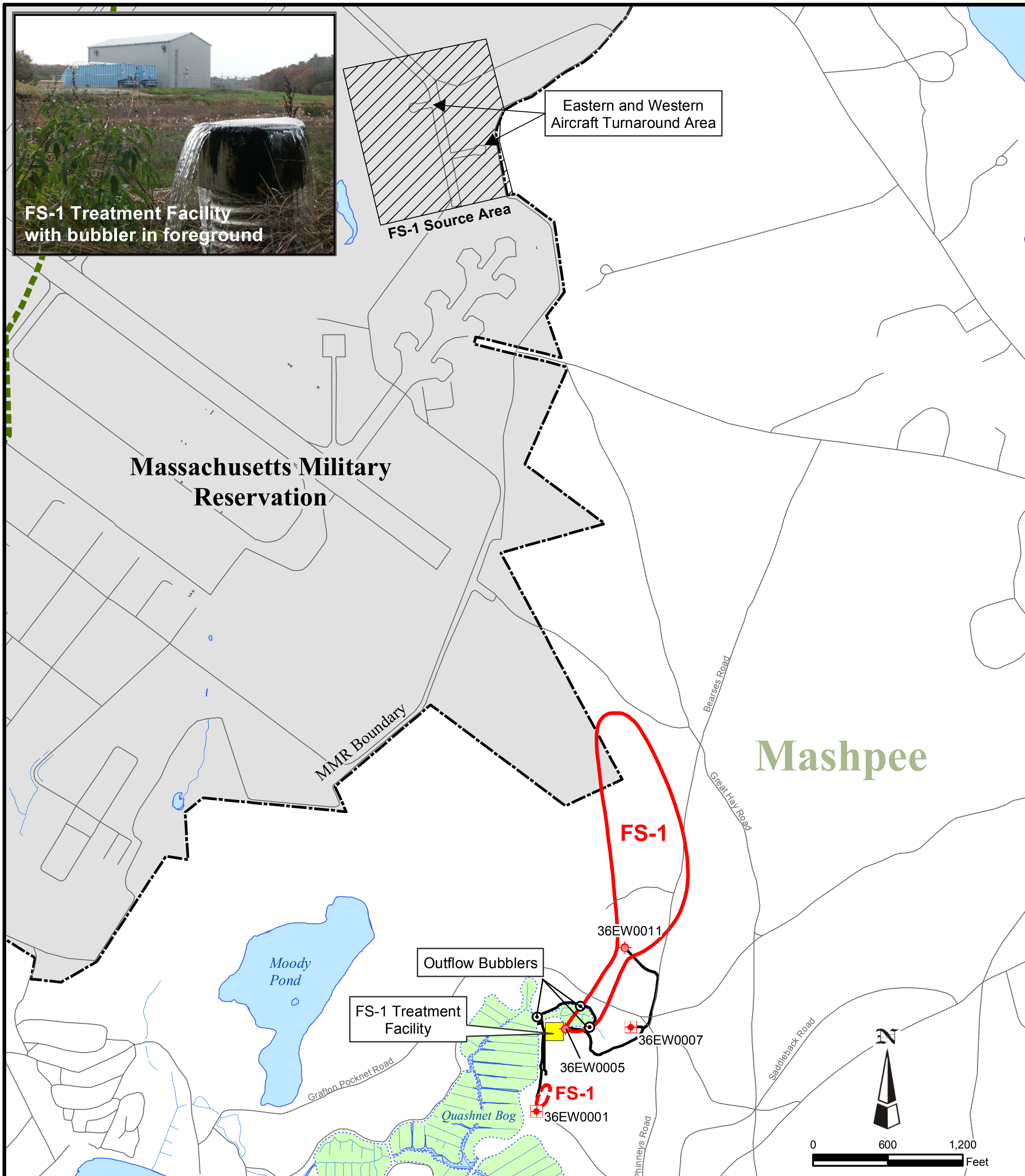

Data Source: AFCEC, February 2013, AFCEC-MMR Data Warehouse
MMR Boundary from Massachusetts Air National Guard 2011

Legend

- FS-1 Plume Boundary = Concentrations exceeding drinking water standards or Massachusetts Maximum Contaminant Level (MMCL). Represents an exceedance of ethylene dibromide (EDB) (EDB MMCL = 0.02 µg/L) (Dashed Where Inferred)
- Massachusetts Military Reservation Boundary
- Town Boundary
- Treatment System Piping
- Outflow Bubbler
- Extraction Well (On)
- Extraction Well (Off)
- Treatment Facility
- Source Area
- BogWetland

FIGURE 5-8A

FS-1 GROUNDWATER PLUME AND TREATMENT SYSTEM

AFCEC - Massachusetts Military Reservation

Final 4th Five-Year Review, 2007-2012

CH2MHILL.

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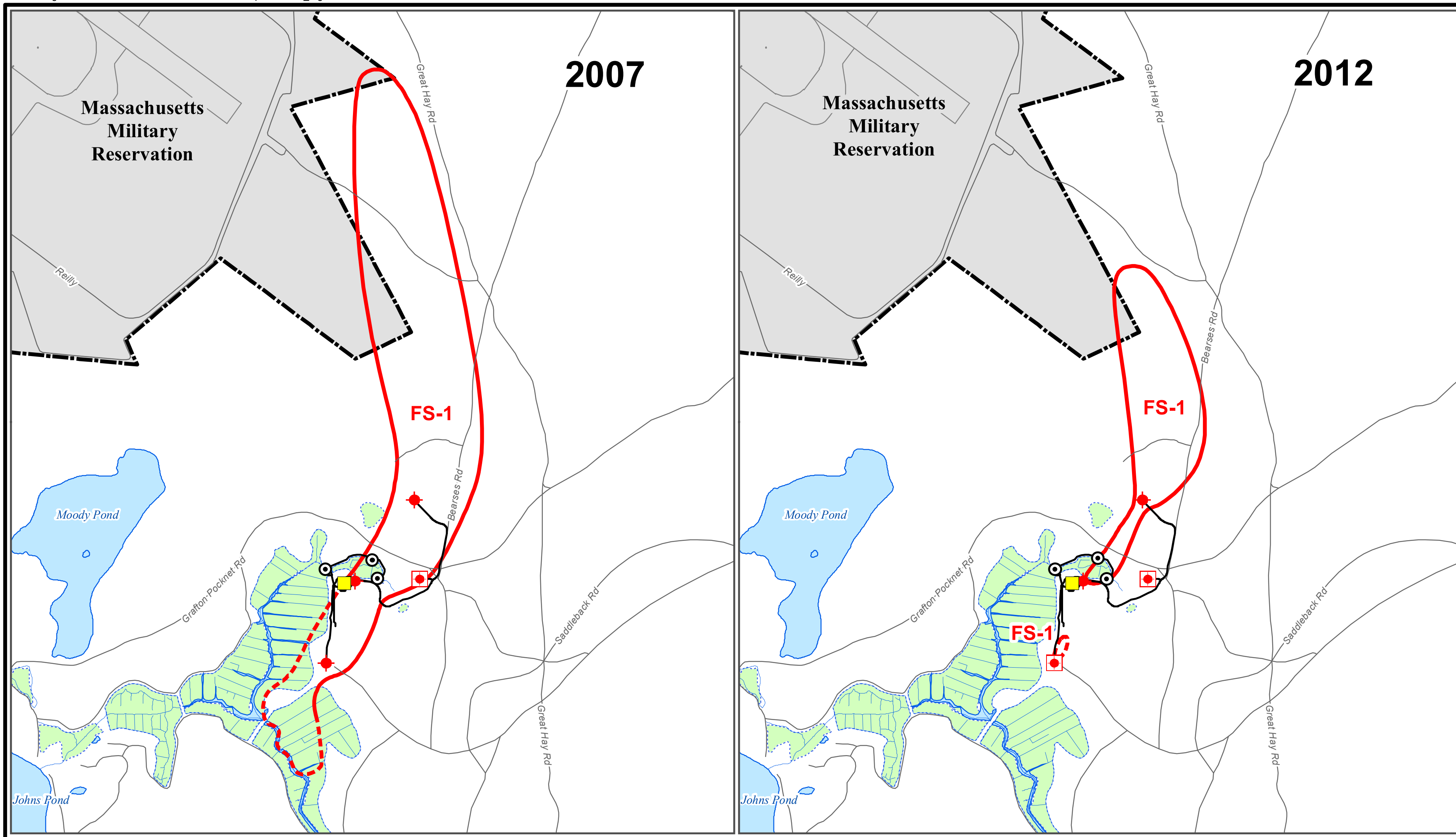

Legend

- Massachusetts Military Reservation Boundary
- Plume Boundary (Dashed Where Inferred)
- Bog/Wetland
- Extraction Well
- Extraction Well (Off)
- Bubbler
- Treatment System Pipeline
- Treatment Facility

Data Source: AFCEC, MMR-AFCEC Data Warehouse
MMR Boundary from Massachusetts Air National Guard 2011

N

0 580 1,160 Feet

FIGURE 5-8B

FS-1 GROUNDWATER PLUME 2007 AND 2012 COMPARISON

AFCEC - Massachusetts Military Reservation

Final 4th Five-Year Review, 2007-2012

CH2MHILL

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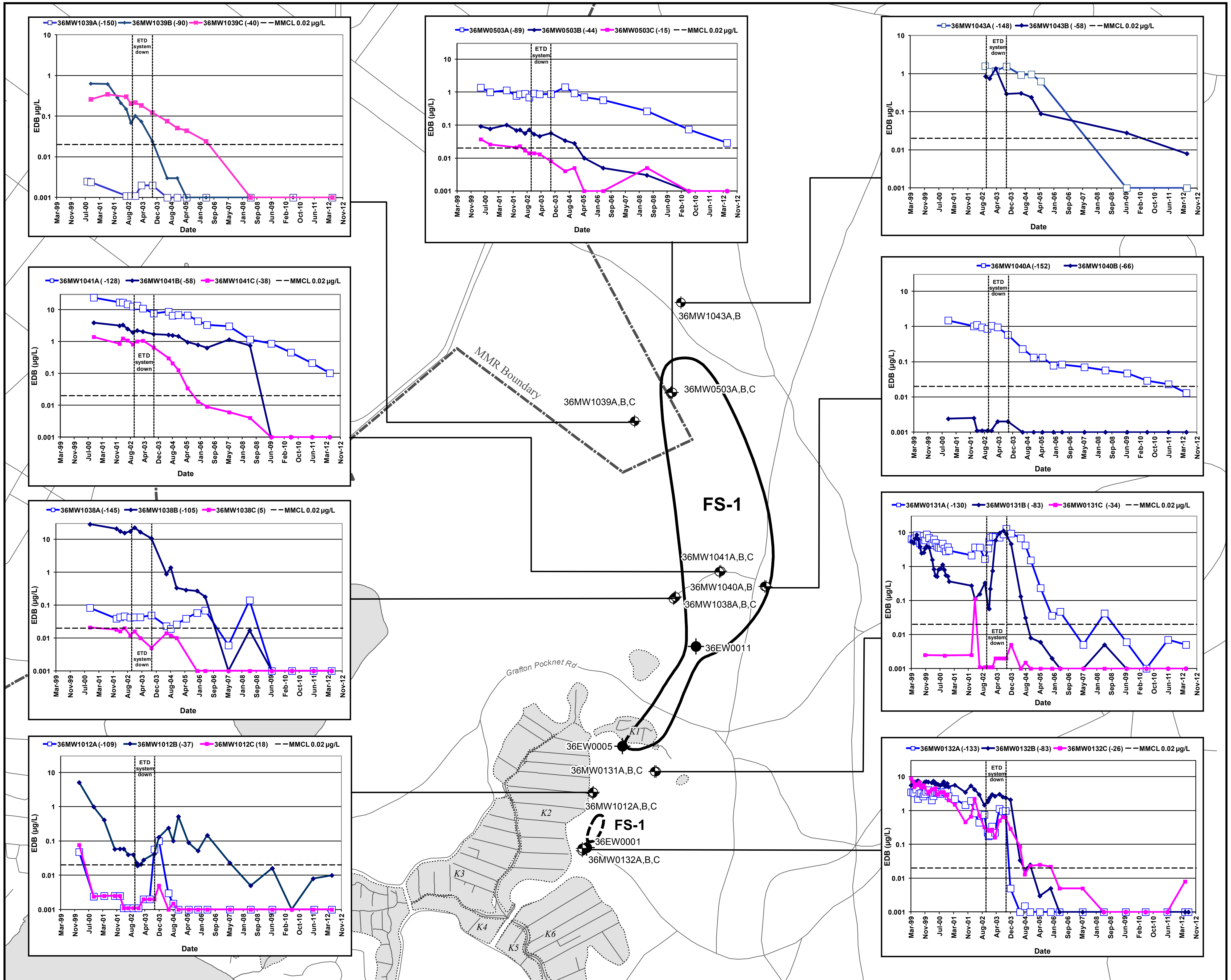

Legend

- Extraction Well
- Monitoring Well
- Massachusetts Military Reservation Boundary
- Plume Boundary (Dashed Where Inferred)
- Bog/Wetland
- (-37) Mid-screen Elevation (ft msl)
- EDB
- EDB
- EDB

N

0 330 660 Feet

Data Source: AFCEC, November 2012, MMR-AFCEC Data Warehouse
MMR Boundary from Massachusetts Air National Guard 2011

FIGURE 5-8C

FS-1 GROUNDWATER CONCENTRATION TRENDS

AFCEC - Massachusetts Military Reservation

Final 4th Five-Year Review, 2007-2012

CH2MHILL

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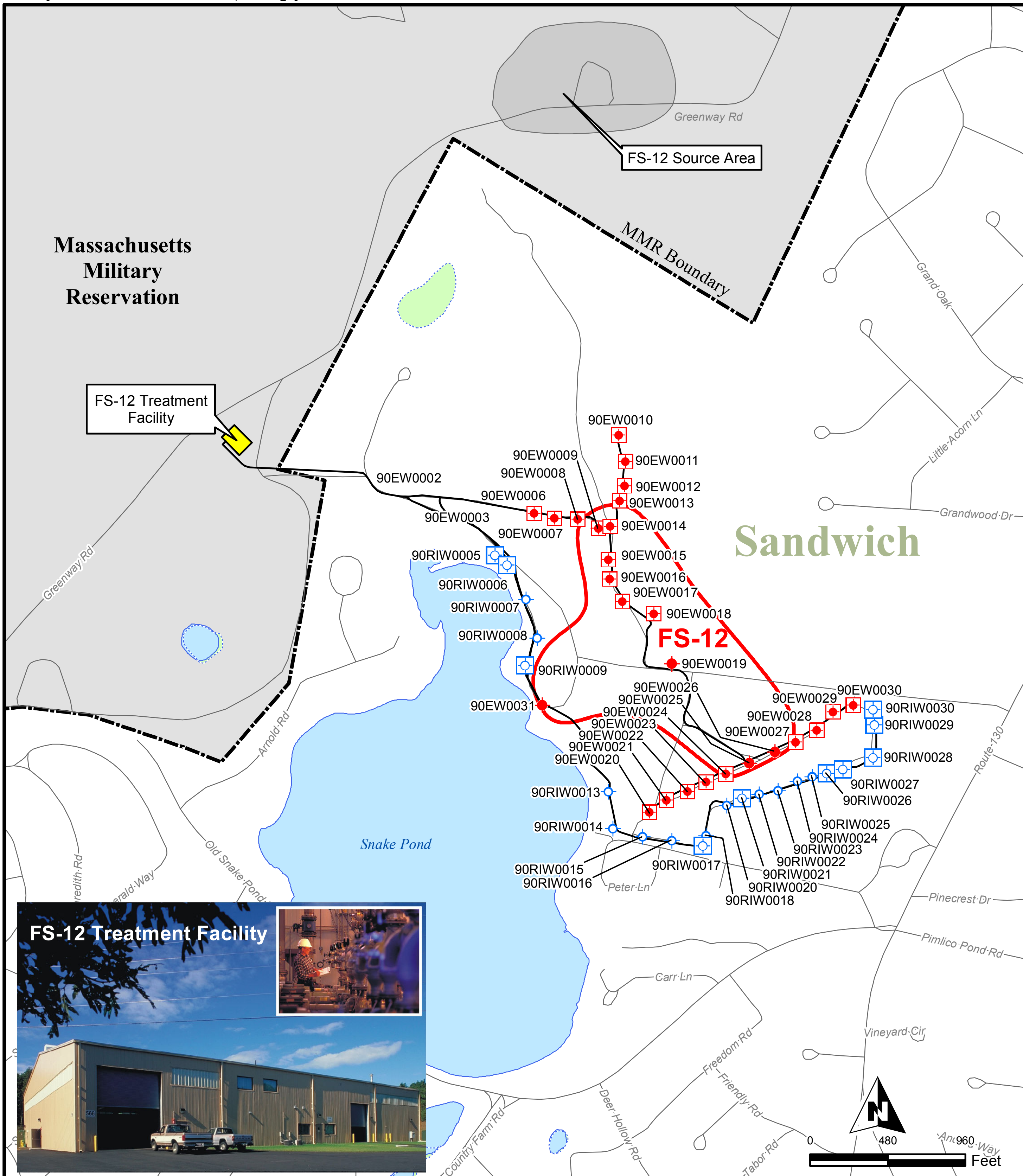

Data Source: AFCEC, February 2013, AFCEC-MMR Data Warehouse
MMR Boundary from Massachusetts Air National Guard 2011

Legend

- FS-12 Plume Boundary = Concentrations exceeding drinking water standards or Massachusetts Maximum Contaminant Level (MMCL). Represents an exceedance of ethylene dibromide (EDB). (EDB MMCL = 0.02 μg/L)
- Treatment System Piping
- Massachusetts Military Reservation Boundary
- Treatment Facility
- Extraction Well (on)
- Extraction Well (off)
- Reinjection Well
- Bog/Wetland
- Source Area

Note: μg/L = micrograms per liter and is a measure of concentration. It is approximately equivalent to parts per billion (ppb).

FIGURE 5-9A

FS-12 GROUNDWATER PLUME AND TREATMENT SYSTEM

AFCEC - Massachusetts Military Reservation

Final 4th Five-Year Review, 2007-2012

CH2MHILL

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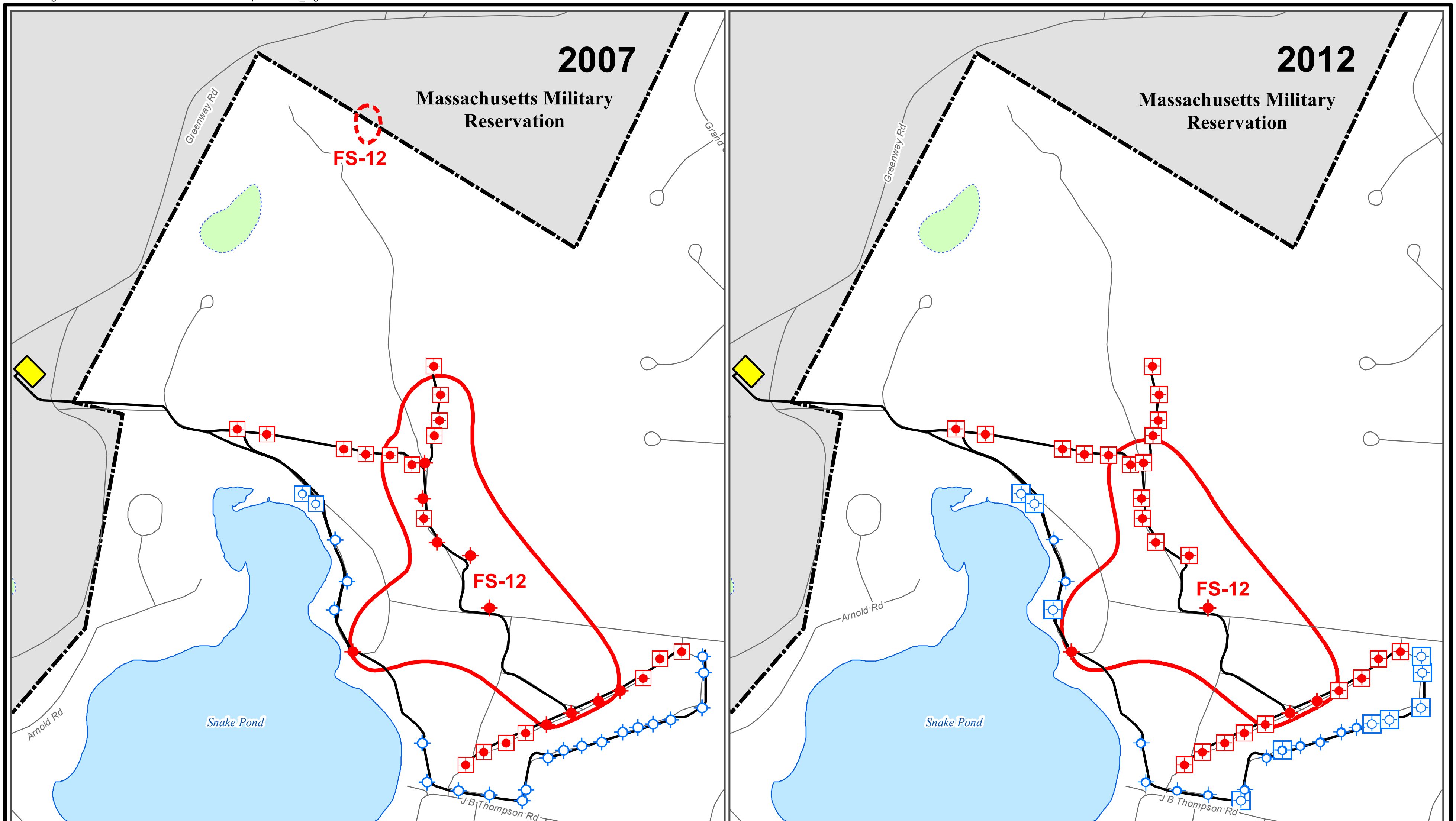


Legend

- Treatment System Pipeline
- Massachusetts Military Reservation Boundary
- Plume Boundary (Dashed Where Inferred)
- Bog/Wetland
- Treatment Plant
- Extraction Well
- Extraction Well (Off)
- Reinjection Well
- Reinjection Well (Off)

Data Source: AFCEC, MMR-AFCEC Data Warehouse
MMR Boundary from Massachusetts Air National Guard 2011

0 410 820
Feet

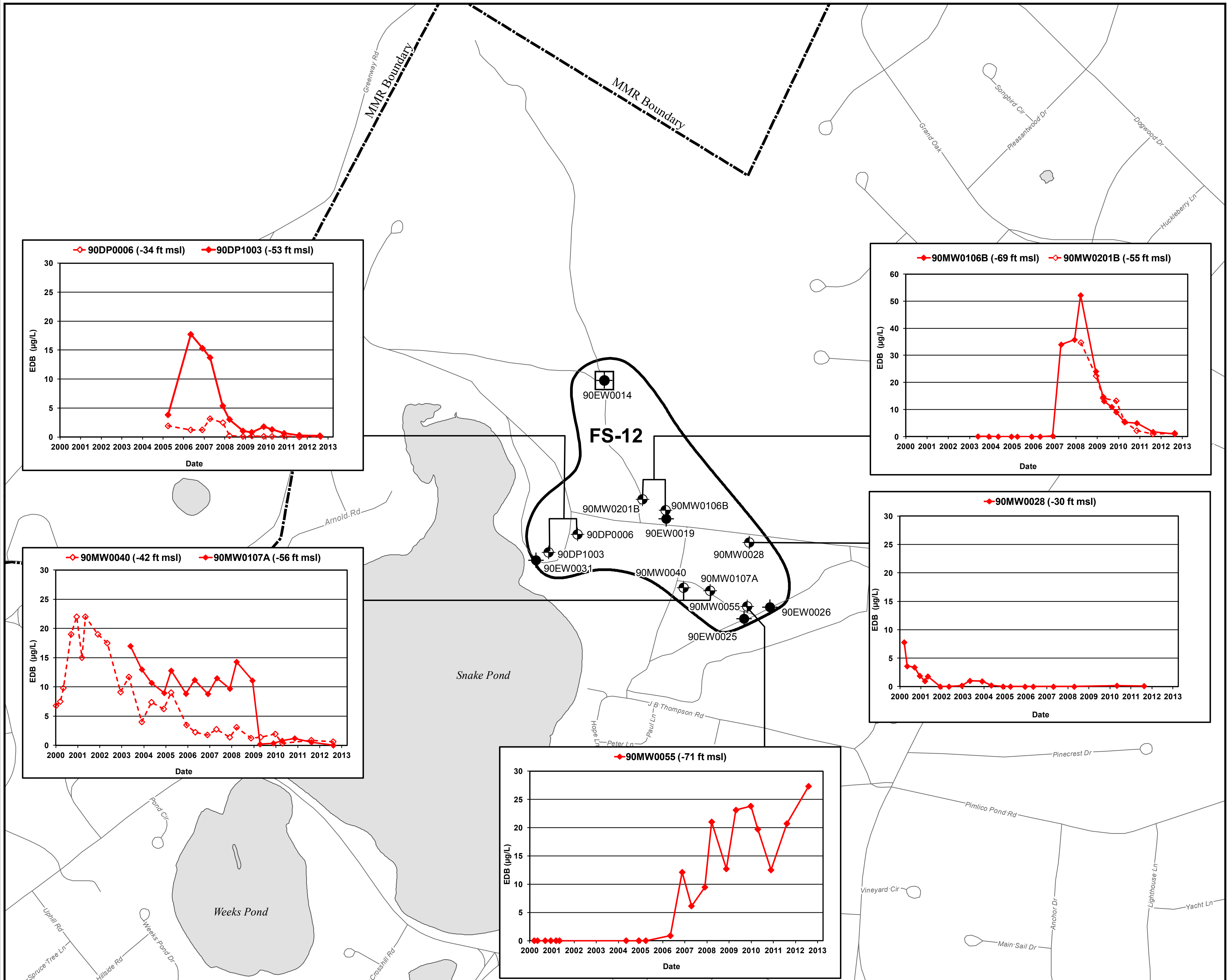
FIGURE 5-9B

FS-12 GROUNDWATER PLUME
2007 AND 2012 COMPARISON

AFCEC - Massachusetts Military Reservation

Final 4th Five-Year Review, 2007-2012

CH2MHILL



Legend

- Monitoring Well
- Extraction Well (On)
- Extraction Well (Off)
- Plume Boundary
- Massachusetts Military Reservation Boundary

Notes:

Value in parentheses after Loc ID on graphs represents the screen elevation in feet mean sea level (ft msl)

EDB Massachusetts Maximum Contaminant Level = 0.02 µg/L

- EDB (solid line)
- EDB (dashed line)

N

0 320 640 Feet

Data Source: AFCEC, January 2013, MMR-AFCEC Data Warehouse
MMR Boundary from Massachusetts Air National Guard 2011

FIGURE 5-9C

FS-12 GROUNDWATER CONCENTRATION TRENDS

AFCEC - Massachusetts Military Reservation

Final 4th Five-Year Review, 2007-2012

CH2MHILL.

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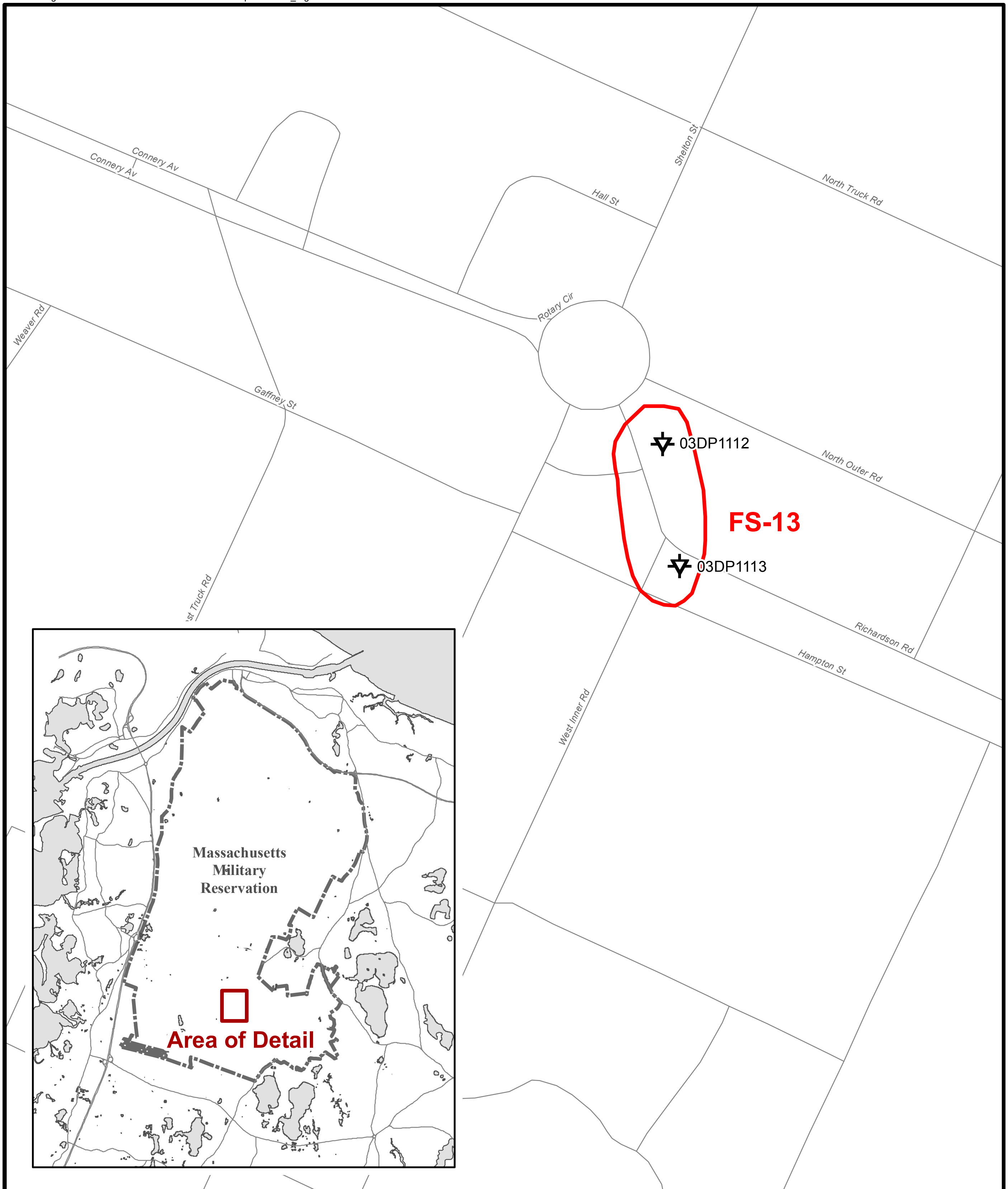

Data Source: AFCEC, MMR-AFCEC Data Warehouse

Legend

- Massachusetts Military Reservation Boundary
- Plume Boundary (Dashed Where Inferred)
- Direct Push Boring Location

N

0 210 420 Feet

FIGURE 5-10

FS-13 GROUNDWATER PLUME (2004 DELINEATION)

AFCEC - Massachusetts Military Reservation

Final 4th Five-Year Review, 2007-2012

CH2MHILL

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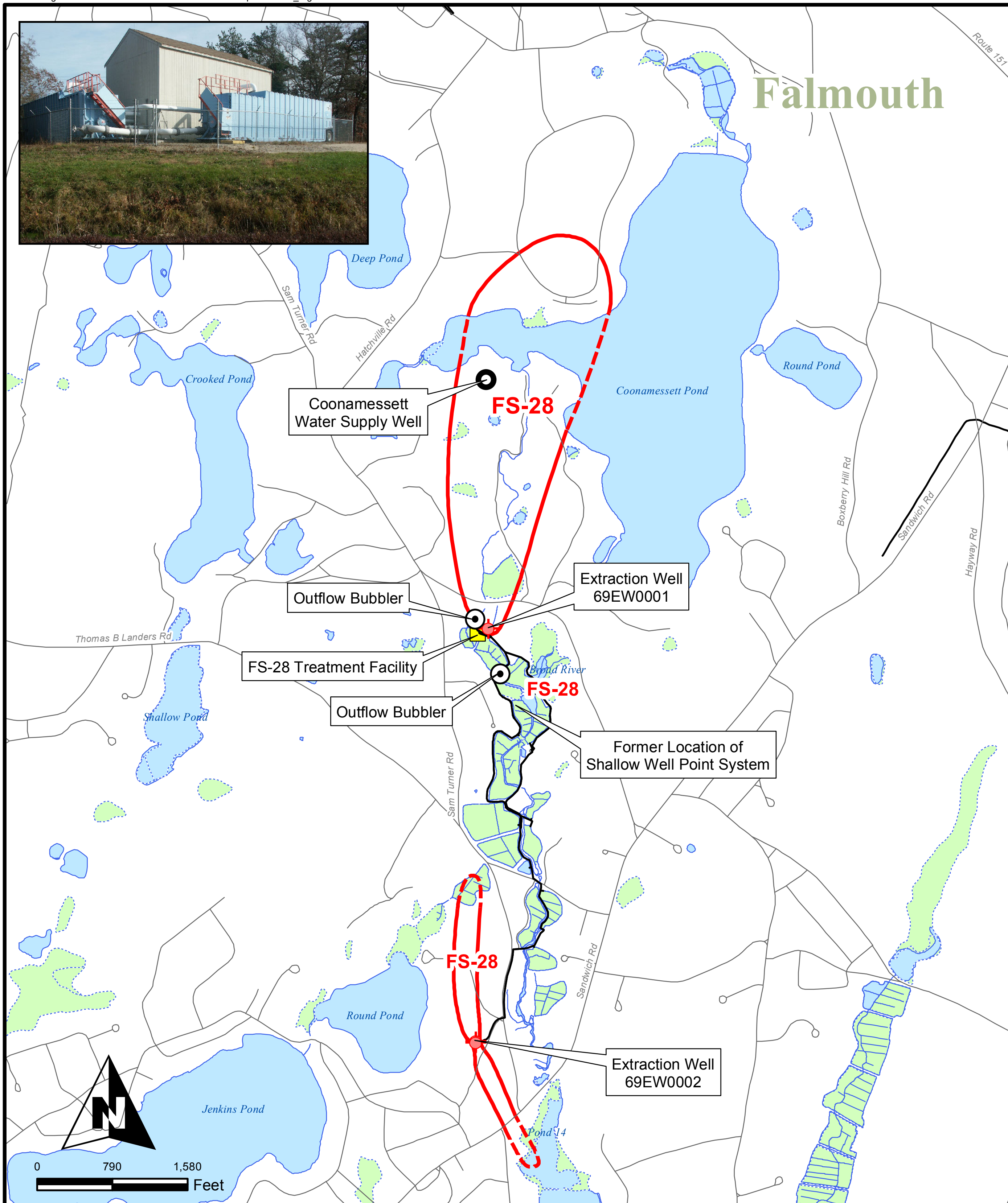


Data Source: AFCEC, February 2013, MMR-AFCEC Data Warehouse

Legend

- FS-28 Plume Boundary = Concentrations exceeding drinking water standards or Massachusetts Maximum Contaminant Level (MMCL), dashed where inferred. Represents an exceedance of ethylene dibromide (EDB) (EDB MMCL = 0.02 µg/L)
- Bog/Wetland
- Treatment System Piping
- Extraction Well
- Outflow Bubbler
- Public Drinking Water Supply Well
- Treatment Facility

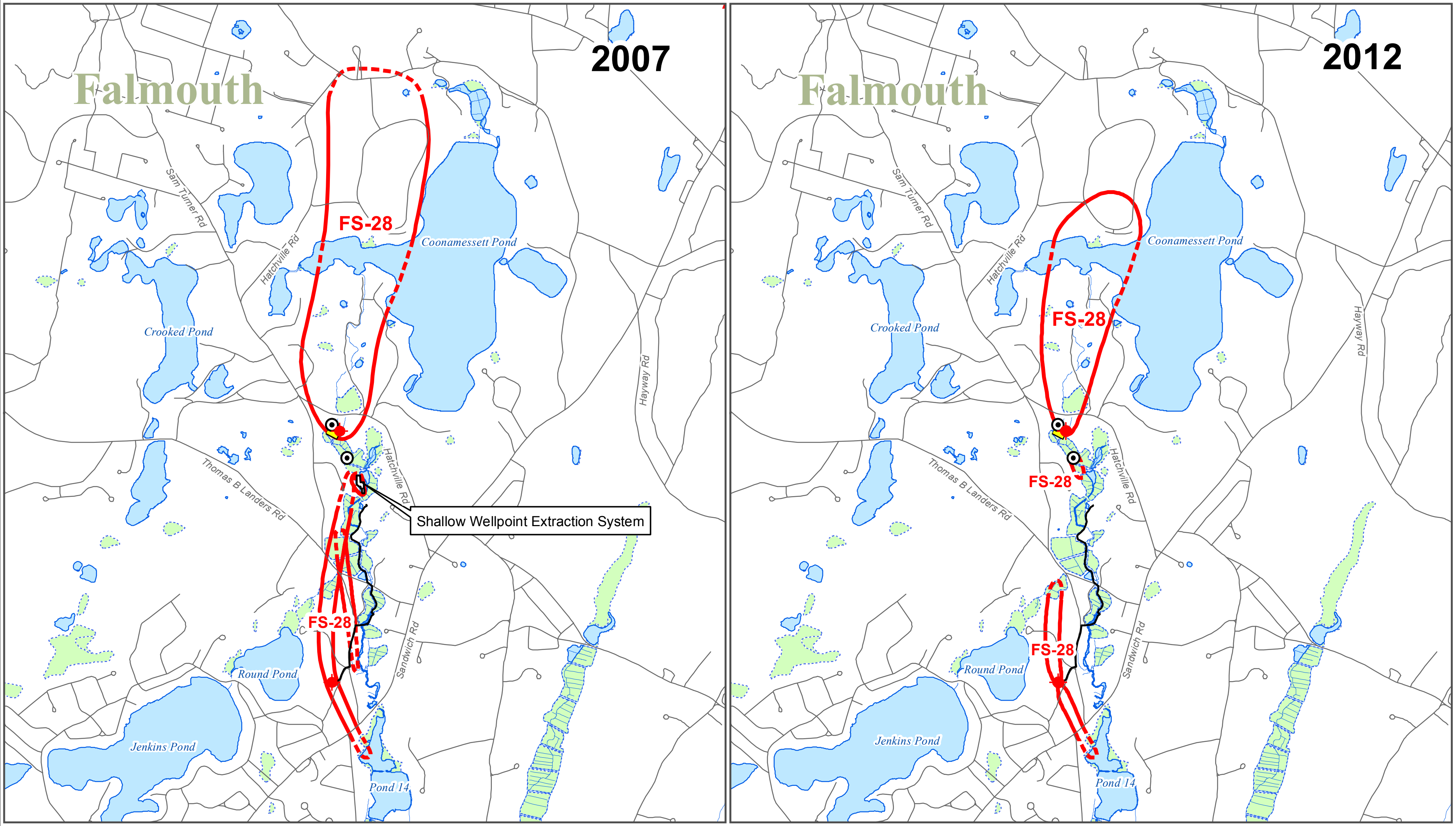
FIGURE 5-11A

FS-28 GROUNDWATER PLUME AND TREATMENT SYSTEM

AFCEC- Massachusetts Military Reservation
Final 4th Five-Year Review, 2007-2012

CH2MHILL.

Path: Y:\Figures\General\5YearReview\2012\GIS\Arcmap\12FiveYr_Fig05-11B.mxd Date: 10/8/2013 Time: 3:26:37 PM User: 1388089411E



Data Source: AFCEC, MMR-AFCEC Data Warehouse
MMR Boundary from Massachusetts Air National Guard 2011

Legend

- Massachusetts Military Reservation Boundary
- Plume Boundary (Dashed Where Inferred)
- Bog/Wetland
- Extraction Well
- Treatment System Pipeline
- Bubbler
- Treatment Facility

0 1,250 2,500
Feet

FIGURE 5-11B

FS-28 GROUNDWATER PLUME 2007 AND 2012 COMPARISON

AFCEC - Massachusetts Military Reservation
Final 4th Five-Year Review, 2007-2012

CH2MHILL

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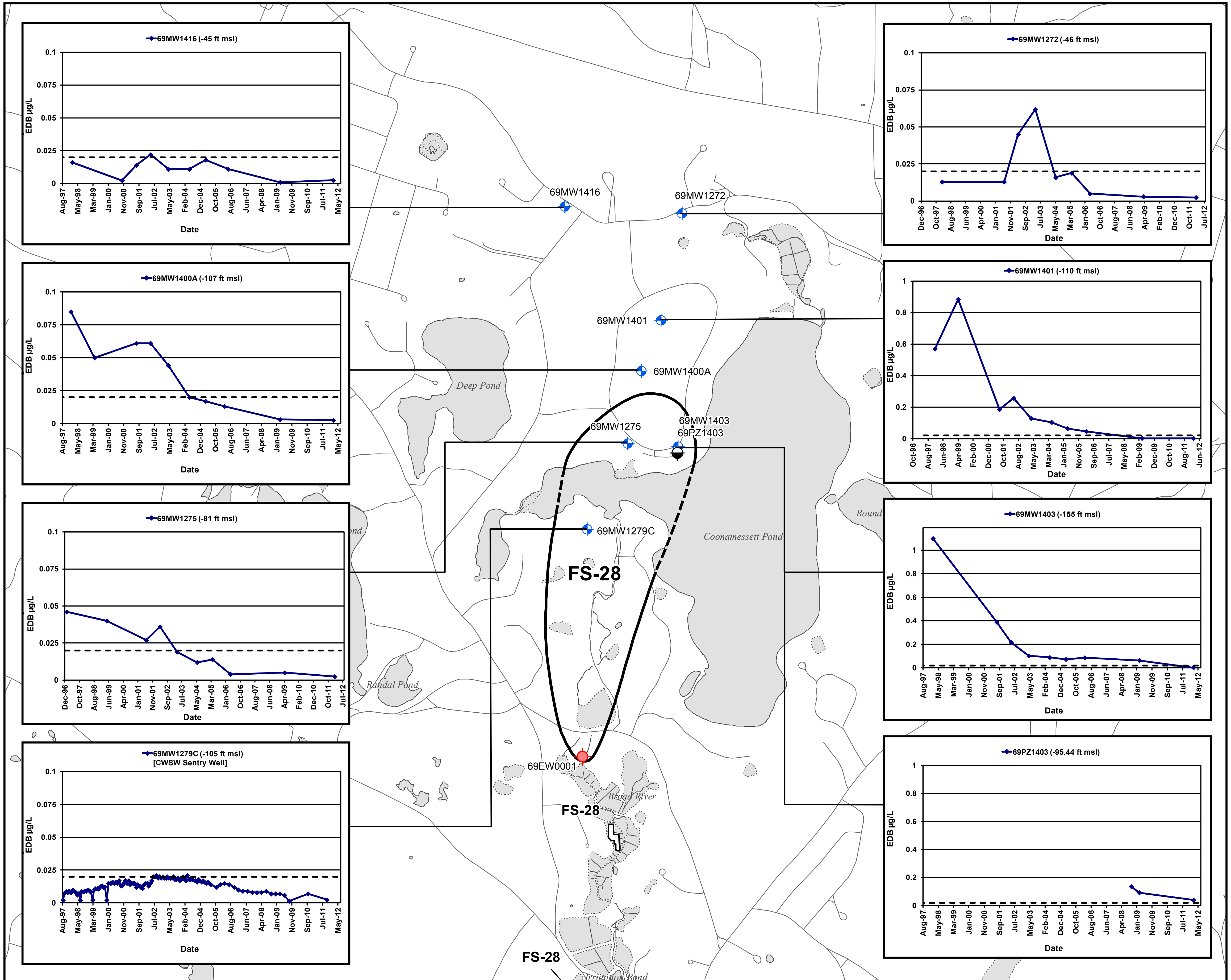

Legend

- Monitoring Well
- Piezometer
- Extraction Well
- Plume Boundary (Dashed Where Inferred)
- EDB MMCL (0.02 µg/L)
- EDB
- Bog/Wetland

0 560 1,120 Feet

Data Source: AFCEC, January 2013, MMR-AFCEC Data Warehouse

FIGURE 5-11C

FS-28 GROUNDWATER CONCENTRATION TRENDS

AFCEC - Massachusetts Military Reservation

Final 4th Five-Year Review, 2007-2012

CH2MHILL.

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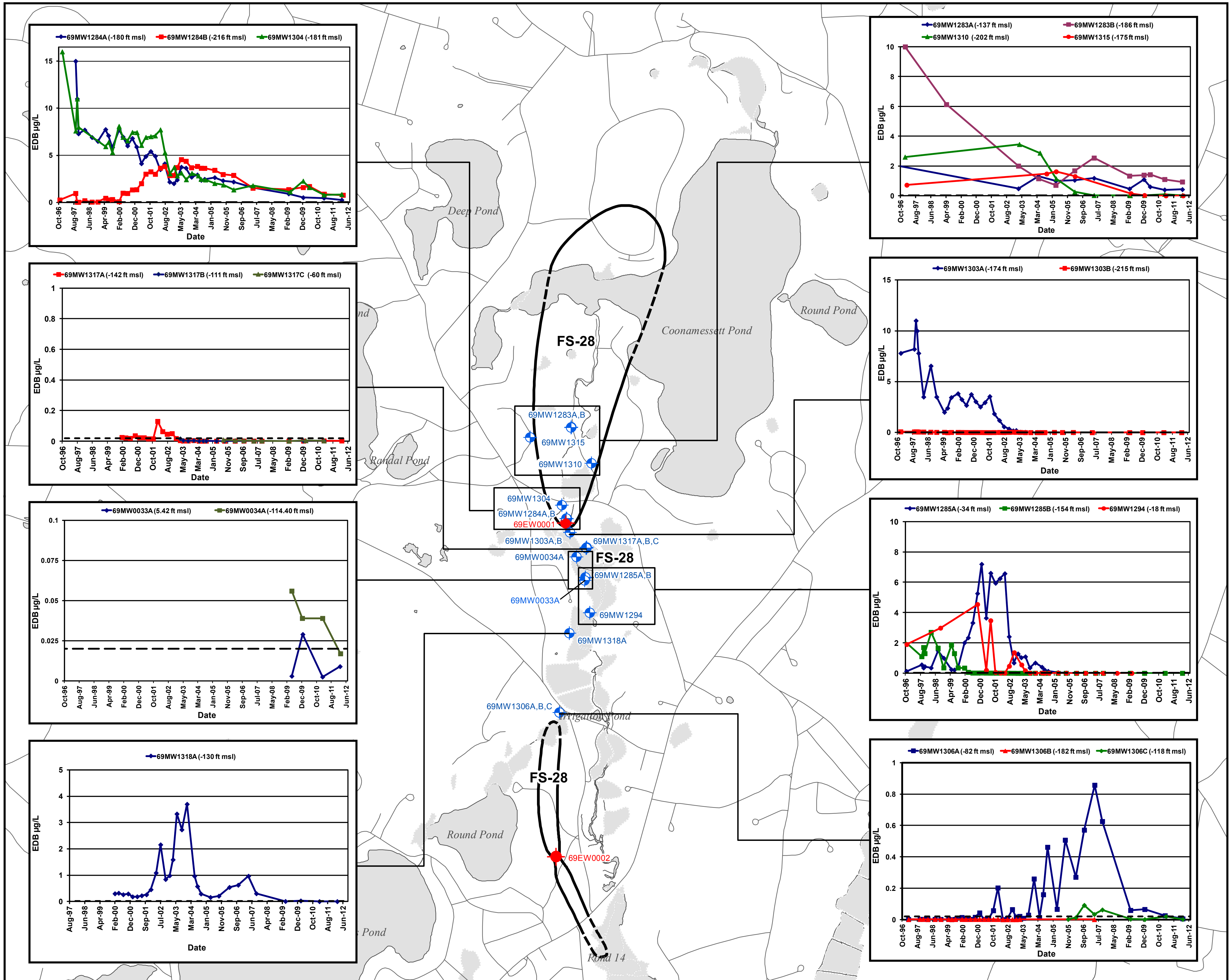


Legend

- Monitoring Well
- Piezometer
- Extraction Well
- EDB MMCL (0.02 µg/L)
- Plume Boundary (Dashed Where Inferred)
- Bog/Wetland

0 640 1,280
Feet

Data Source: AFCEC, January 2013, MMR-AFCEC Data Warehouse

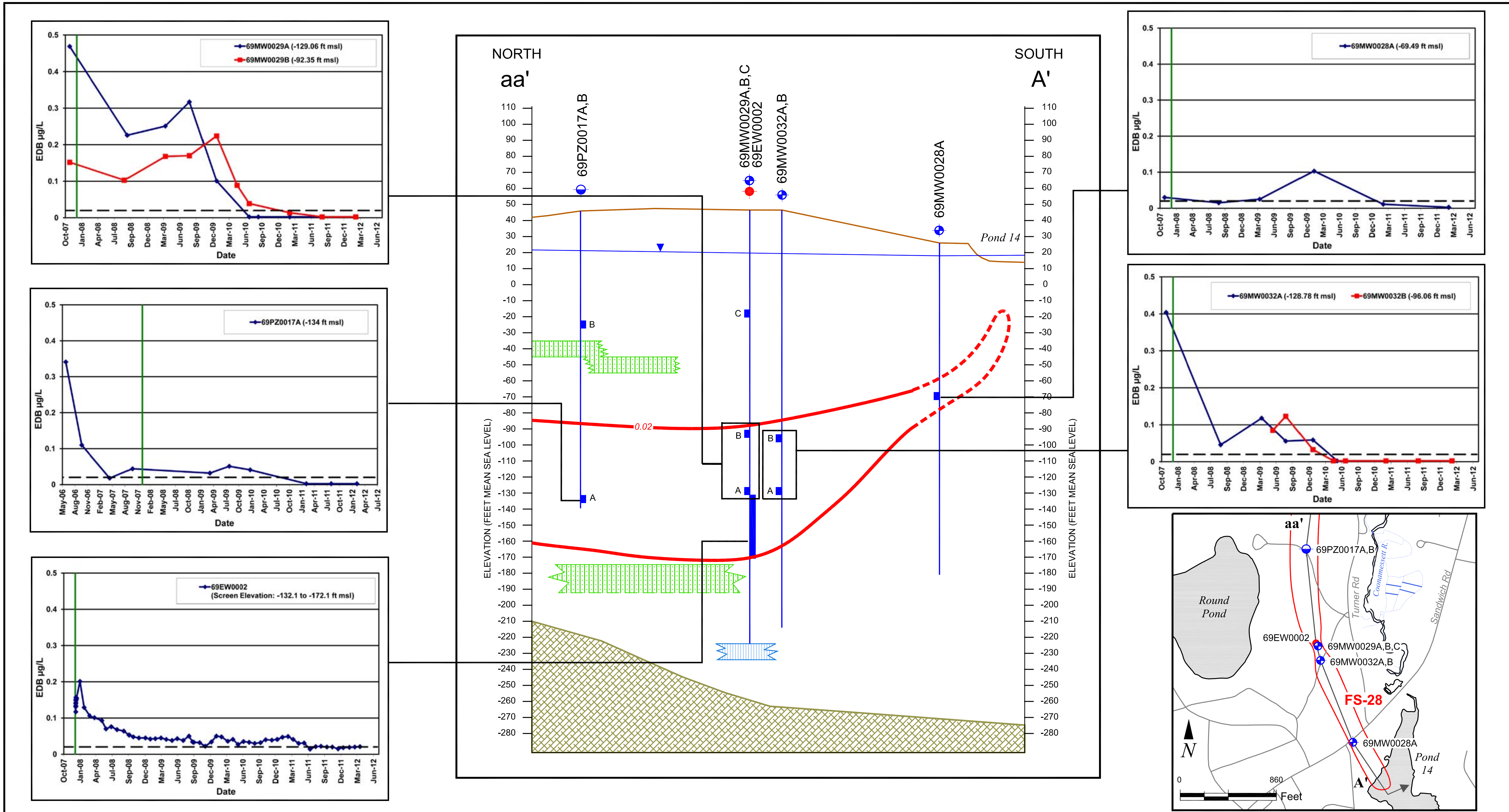
FIGURE 5-11D

FS-28 GROUNDWATER CONCENTRATION TRENDS

AFCEC - Massachusetts Military Reservation

Final 4th Five-Year Review, 2007-2012

CH2MHILL.



Legend

- Monitoring Well
- Piezometer
- Extraction Well
- Water Table
- A Well Screen ID
- Silt
- Silty Sand
- Bedrock
- 0.02 Plume Boundary (Dashed Where Inferred)
- Startup of 69EW0002 (11 December 2007)
- EDB MMCL (0.02 µg/L)
- EDB
- EDB

Data Source: AFCEC, January 2013, MMR AFCEC Data Warehouse

V: 60
H: 480
0 Feet

FIGURE 5-11E

FS-28 GROUNDWATER CONCENTRATION TRENDS

AFCEC - Massachusetts Military Reservation

Final 4th Five-Year Review, 2007-2012

CH2MHILL.

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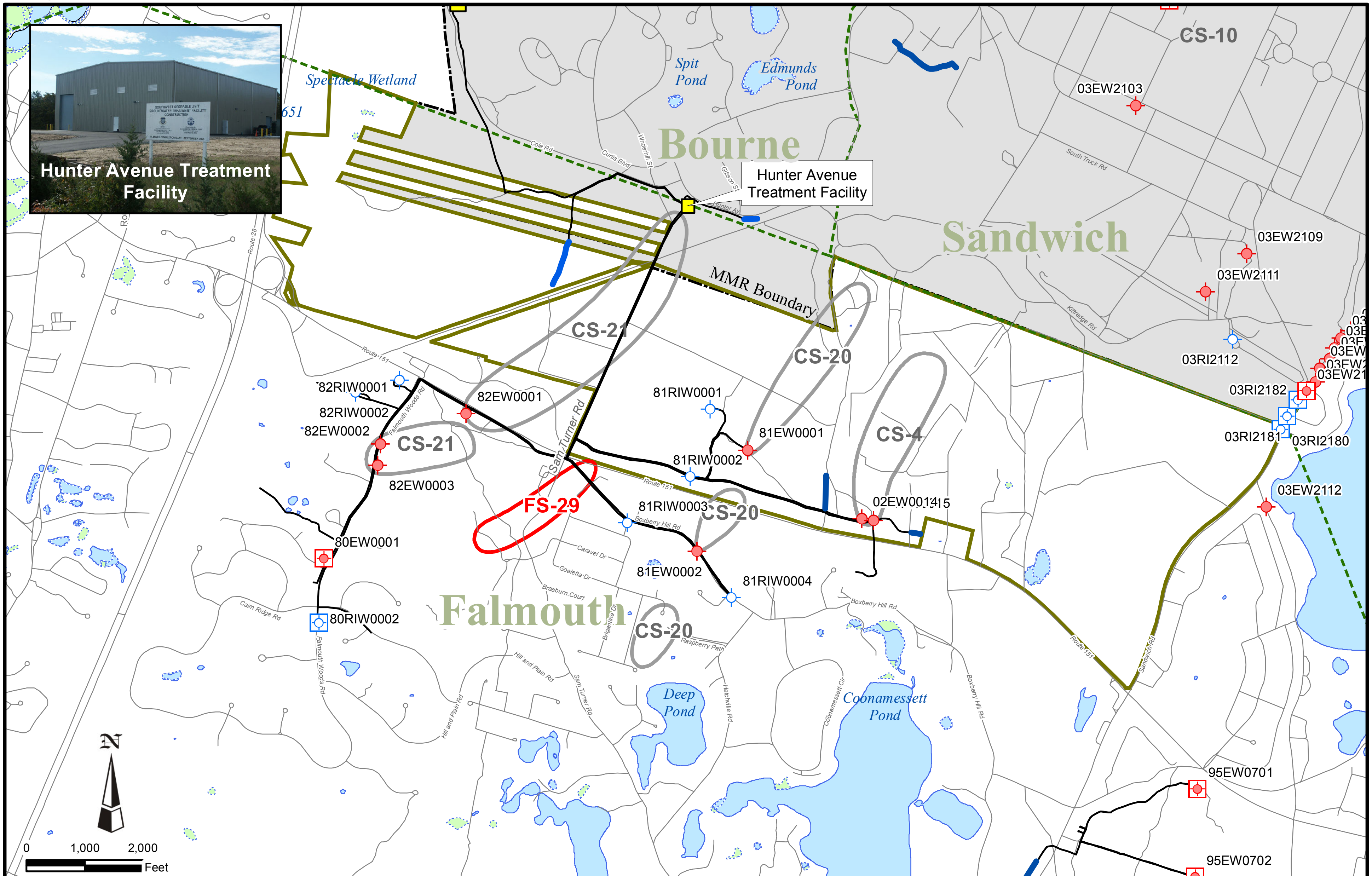

Legend

- FS-29 Plume Boundary = Concentrations exceeding drinking water standards. Represents an exceedance of ethylene dibromide (EDB) or carbon tetrachloride (CCl_4) (EDB MMCL = 0.02, CCl_4 MCL = 5 μg/L)
- Other Plume Boundary
- Massachusetts Military Reservation Boundary
- Town Boundary
- Infiltration Gallery/Trench
- Pipeline
- Treatment Facility
- Bog/Wetland
- Crane Wildlife Management Area
- Extraction Well (On)
- Extraction Well (Off)
- Reinjection Well (On)
- Reinjection Well (Off)

Data Source: AFCEC, February 2013, AFCEC-MMR Data Warehouse
MMR Boundary from Massachusetts Air National Guard 2011

FIGURE 5-12A

FS-29 GROUNDWATER PLUME AND TREATMENT SYSTEM

AFCEC - Massachusetts Military Reservation

Final 4th Five-Year Review, 2007-2012

CH2MHILL

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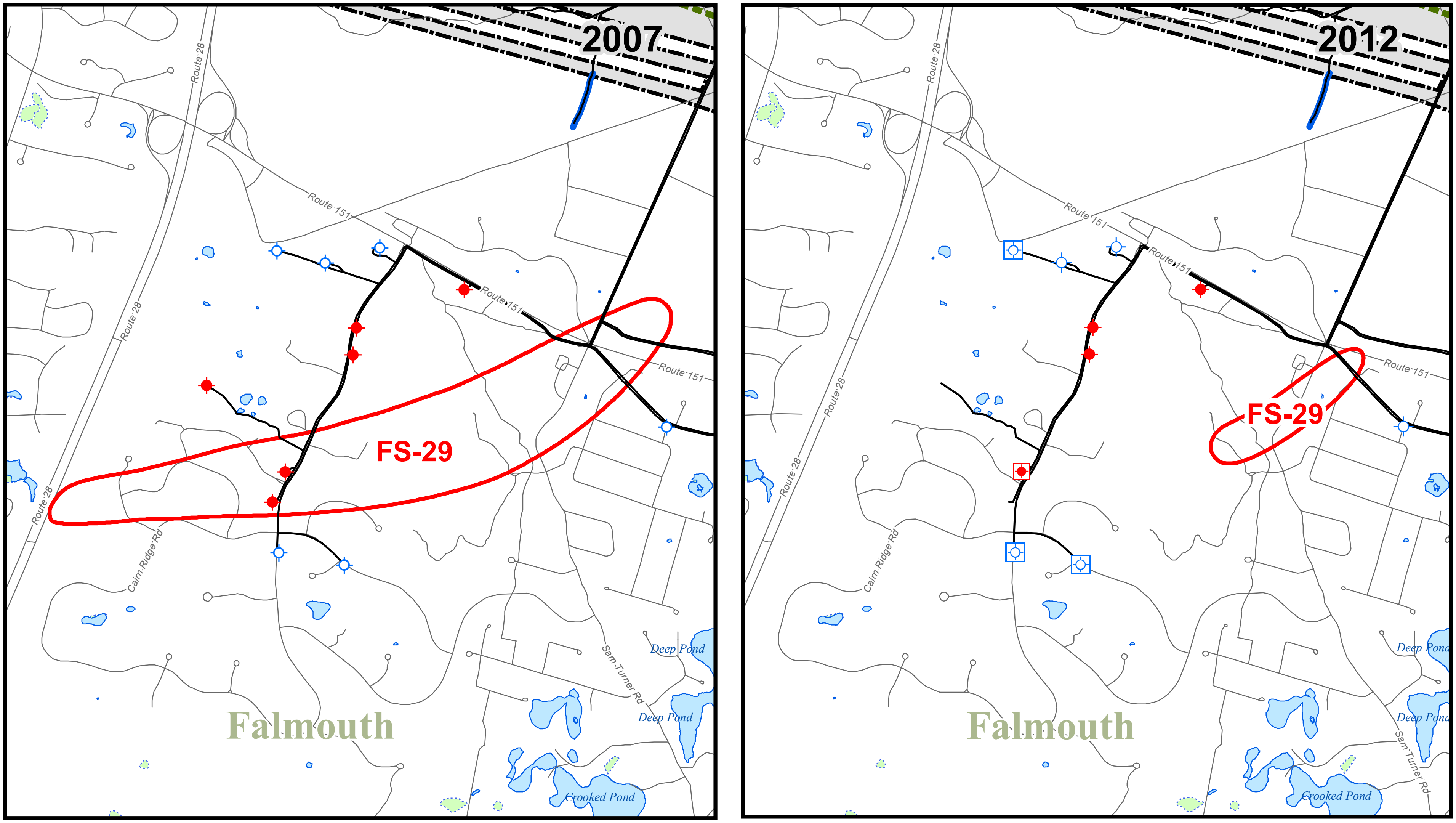

Legend

- Town Boundary
- Massachusetts Military Reservation Boundary
- Plume Boundary
- Bog/Wetland
- Treatment System Piping
- Infiltration Trench
- Extraction Well
- Extraction Well (Off)
- Reinjection Well
- Reinjection Well (Off)

Data Source: AFCEE, MMR-AFCEE Data Warehouse
MMR Boundary from Massachusetts Air National Guard 2011

N

0   1,000   2,000 Feet

FIGURE 5-12B

FS-29 GROUNDWATER PLUME 2007 AND 2012 COMPARISON

AFCEE - Massachusetts Military Reservation

Final 4th Five-Year Review, 2007-2012

CH2MHILL

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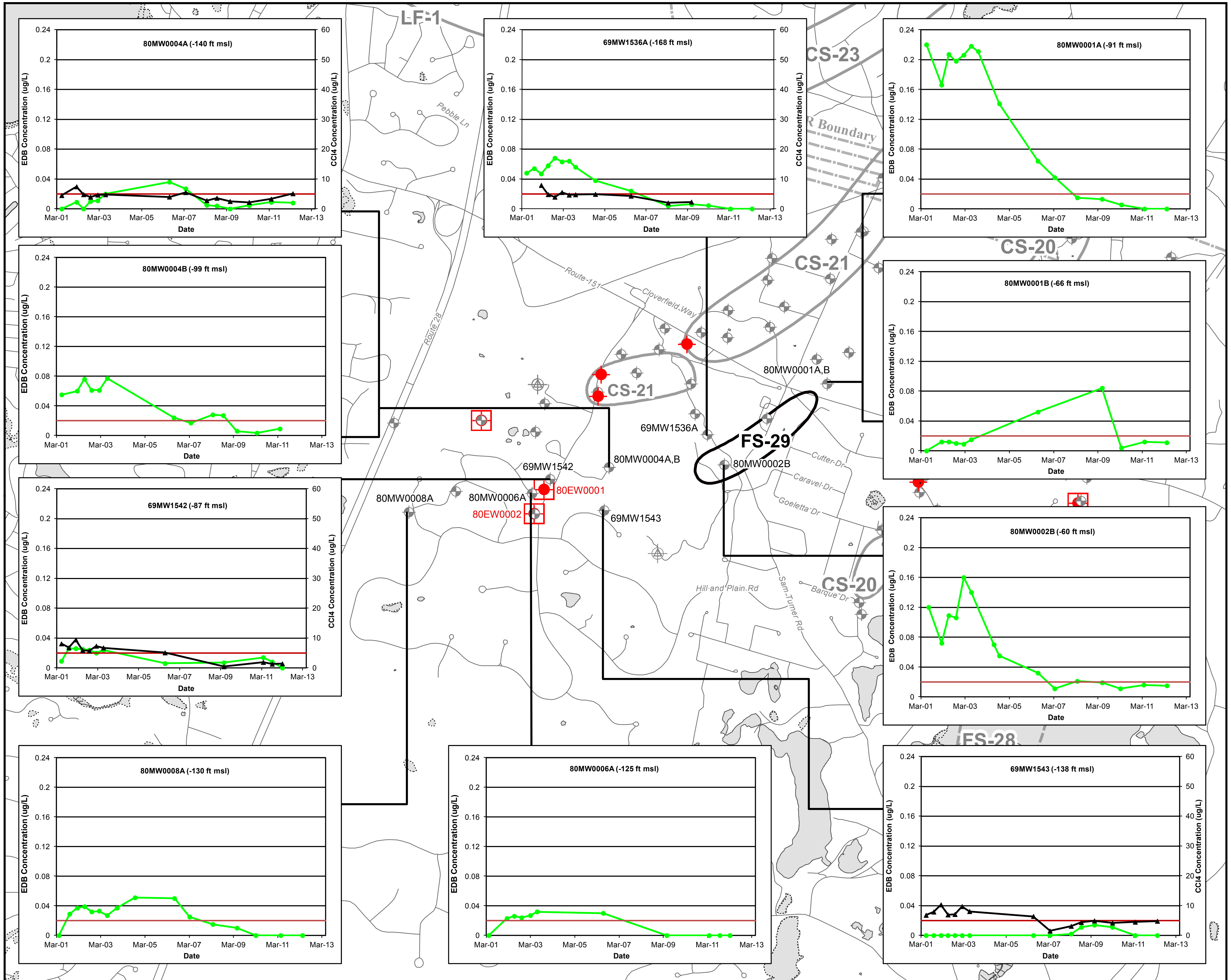

Legend

- Monitoring Well
- Extraction Well (On)
- Extraction Well (Off)
- Reinjection Well (On)
- Reinjection Well (Off)
- Irrigation Well
- Massachusetts Military Reservation Boundary
- FS-29 Plume Boundary
- Other Plume Boundary
- EDB
- CCl_4
- EDB MMCL (0.02 µg/L) and CCl_4 MCL (5 µg/L)
- ft msl — Feet Mean Sea Level

0 1,000 2,000 Feet

Data Source: AFCEC, January 2013, MMR-AFCEC Data Warehouse
MMR Boundary from Massachusetts Air National Guard 2011

FIGURE 5-12C

FS-29 GROUNDWATER CONCENTRATION TRENDS

AFCEC - Massachusetts Military Reservation

Final 4th Five-Year Review, 2007-2012

CH2MHILL.

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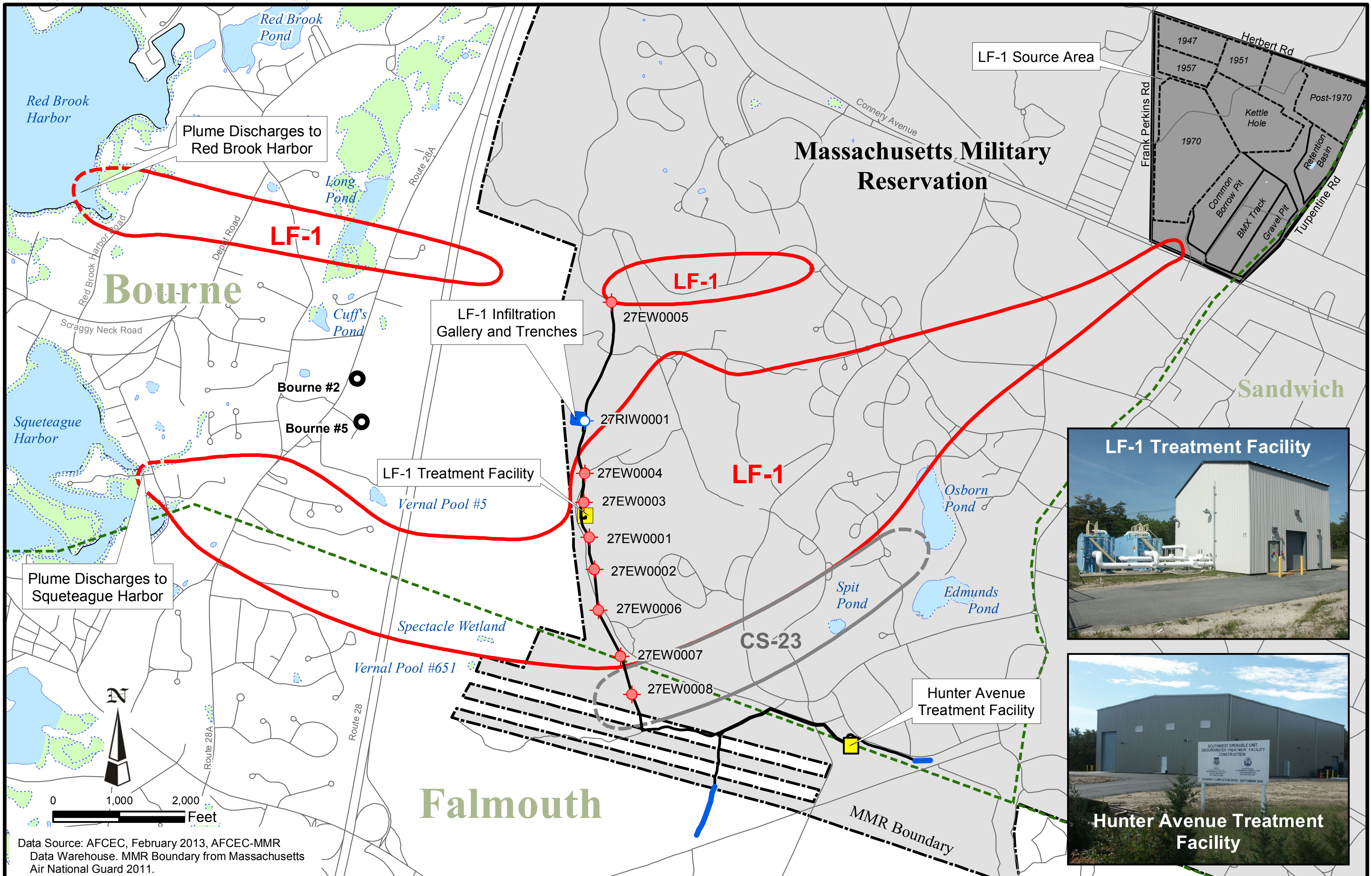

Legend

LF-1 Plume Boundary = Concentrations exceeding drinking water standards or Maximum Contaminant Level (MCL). (Dashed where inferred.)
Represents an exceedance of:
Trichloroethene (TCE): MCL = 5 µg/L
Tetrachloroethene (PCE): MCL = 5 µg/L
Carbon Tetrachloride (CCl_4): MCL = 5 µg/L
1,4-Dichlorobenzene (1,4-DCB): MMCL = 5 µg/L
1,1,2,2-Tetrachloroethane (1,1,2,2-TeCA): GW-1 = 2 µg/L
Vinyl Chloride (VC): MCL = 2 µg/L
Ethylene Dibromide (EDB): MMCL = 0.02 µg/L
Manganese (Mn): EPA HA = 300 µg/L

Extraction Well
Reinjection Well
Public Water Supply Well
Source Area
Treatment Facility
Bog/Wetland

Other Plume Boundary (Dashed Where Inferred)
Massachusetts Military Reservation Boundary
Town Boundary
Infiltration Gallery/Trench
Landfill Cell Boundary
Other Landfill Area Boundary

FIGURE 5-13A

LF-1 GROUNDWATER PLUME AND TREATMENT SYSTEMS

AFCEC - Massachusetts Military Reservation
Final 4th Five-Year Review, 2007-2012

CH2MHILL

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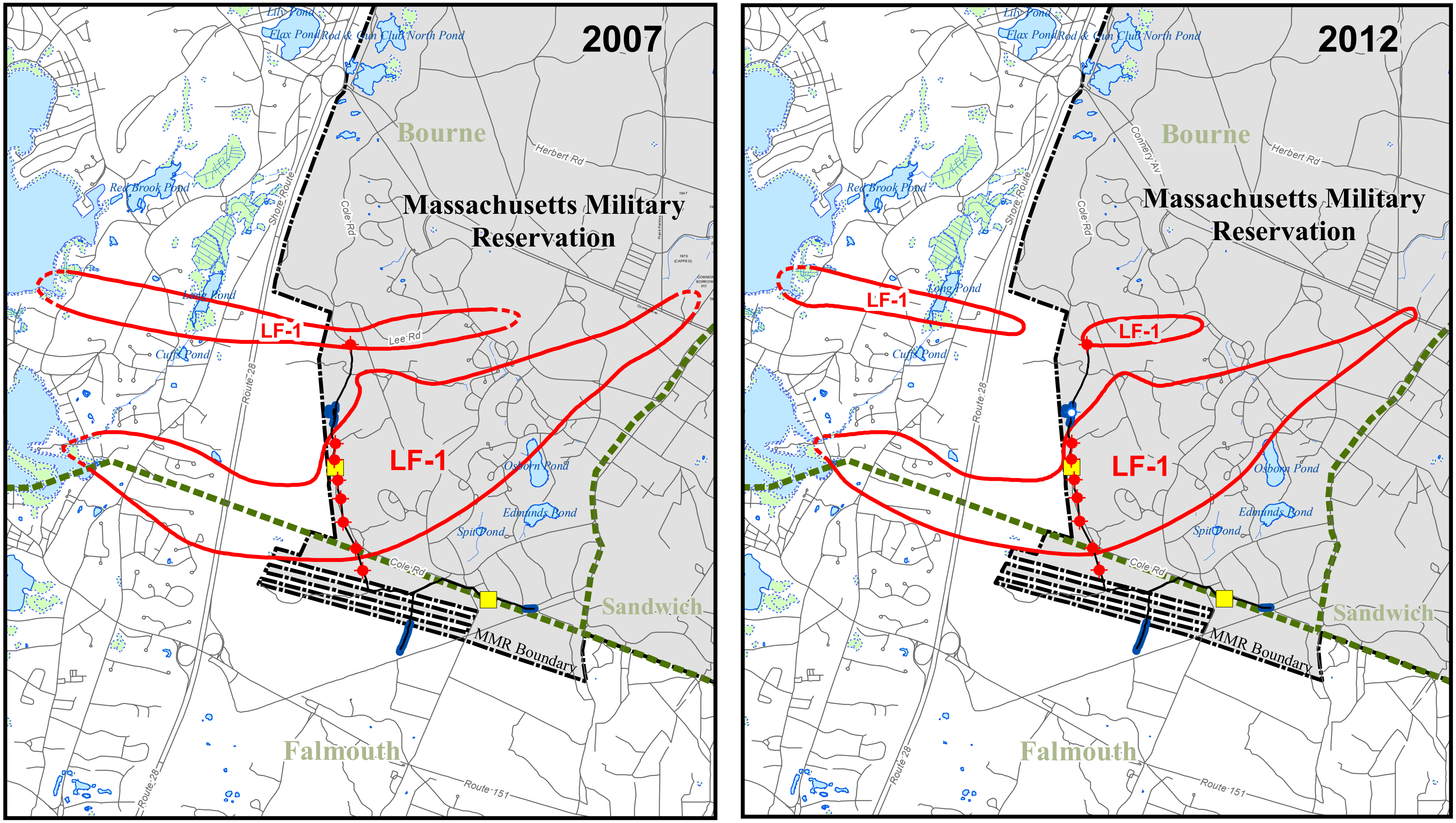

Legend

- Town Boundary
- Massachusetts Military Reservation Boundary
- Plume Boundary (Dashed Where Inferred)
- Bog/Wetland
- Treatment System Pipeline
- Infiltration Trench
- Extraction Well
- Reinjection Well
- Treatment Facility

Data Source: AFCEE, MMR-AFCEE Data Warehouse
MMR Boundary from Massachusetts Air National Guard 2011

N

0 1,900 3,800 Feet

FIGURE 5-13B

LF-1 GROUNDWATER PLUME 2007 AND 2012 COMPARISON

AFCEE - Massachusetts Military Reservation

Final 4th Five-Year Review, 2007-2012

CH2MHILL.

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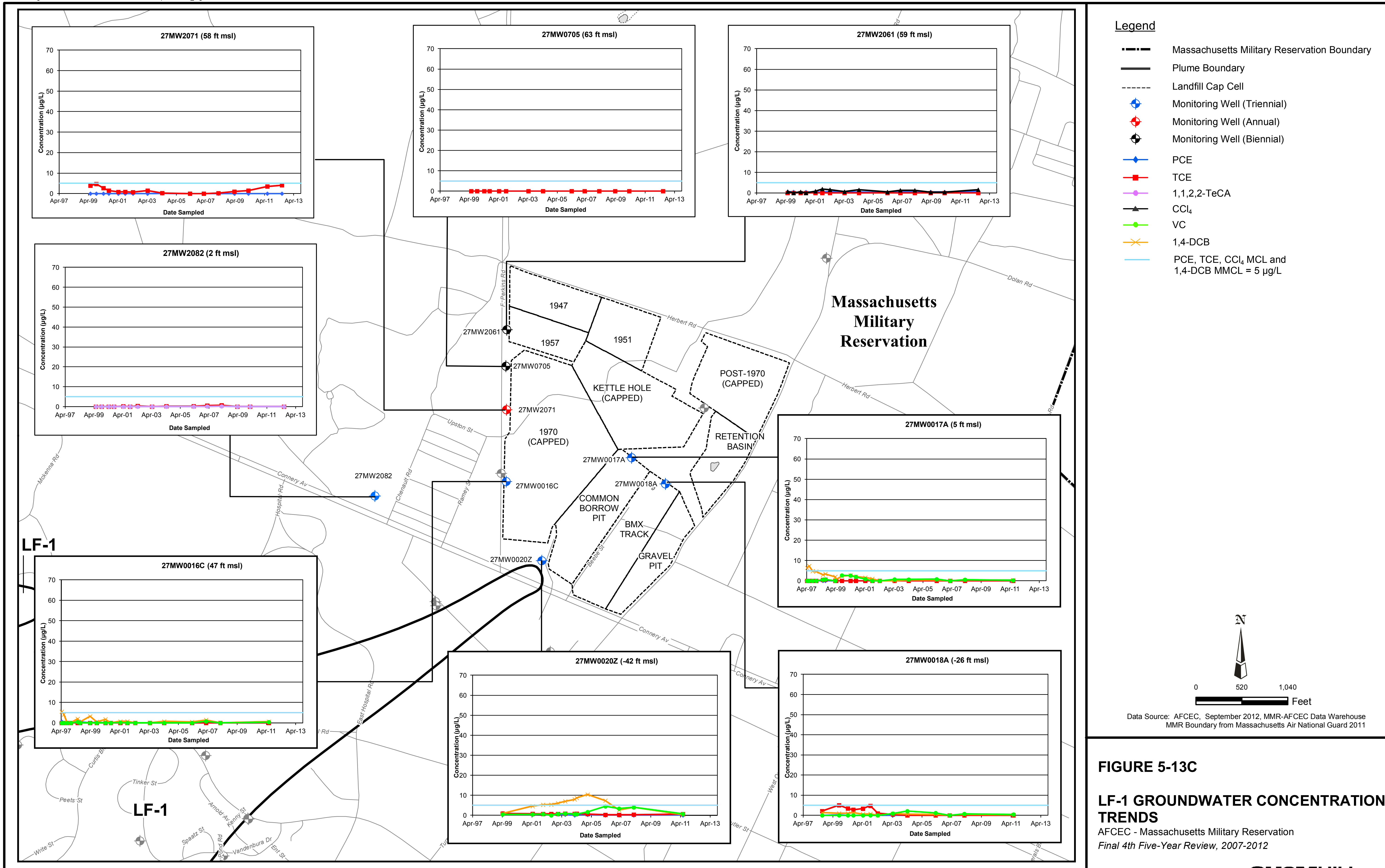


Data Source: AFCEC, September 2012, MMR-AFCEC Data Warehouse
MMR Boundary from Massachusetts Air National Guard 2011

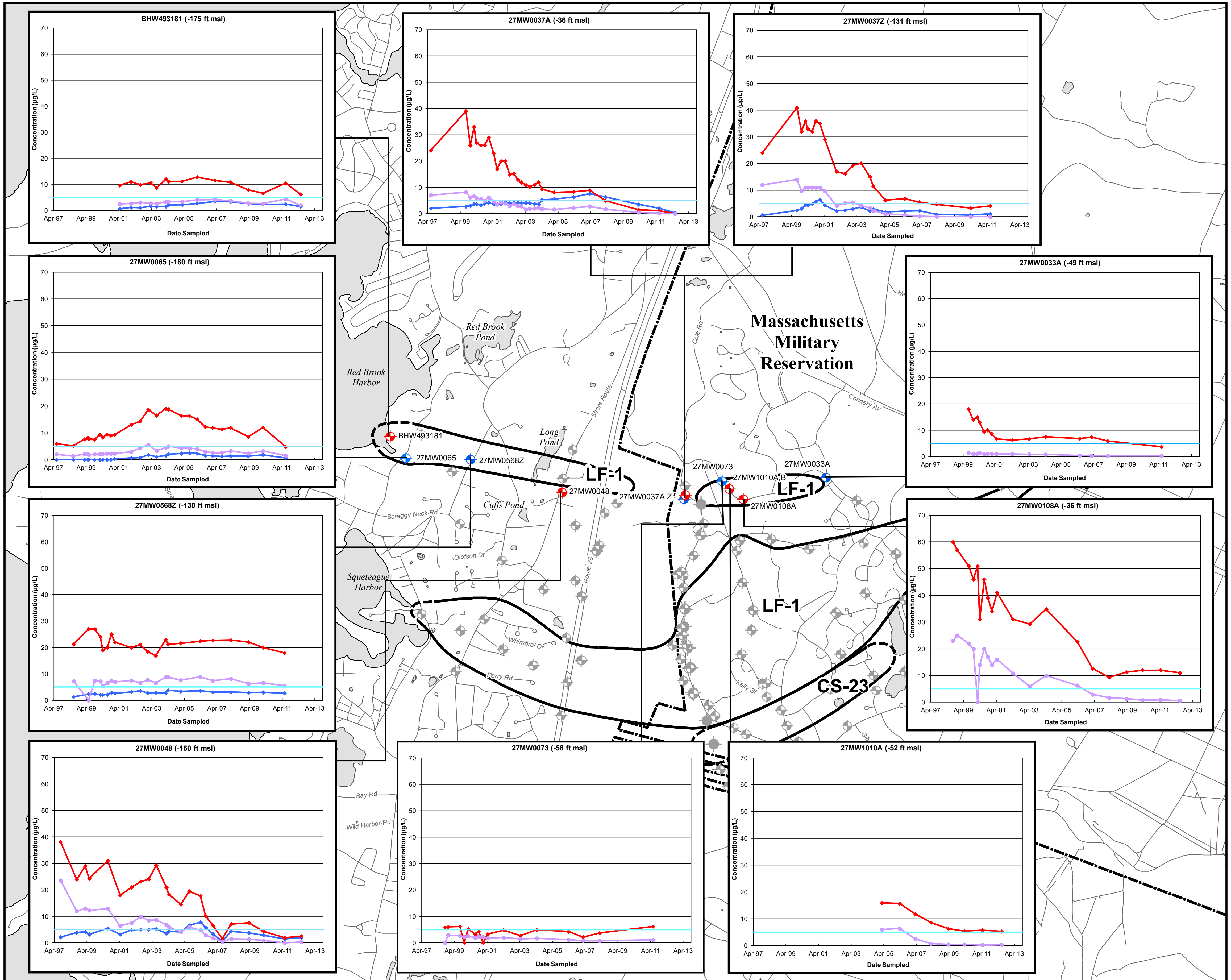
FIGURE 5-13C

LF-1 GROUNDWATER CONCENTRATION TRENDS

AFCEC - Massachusetts Military Reservation

Final 4th Five-Year Review, 2007-2012

CH2MHILL.



Legend

- Massachusetts Military Reservation Boundary
- Plume Boundary (Dashed Where Inferred)
- Monitoring Well (Triennial)
- Monitoring Well (Annual)
- PCE
- TCE
- 1,1,2,2-TeCA
- PCE and TCE MCL = 5 µg/L

0 1,400 2,800 Feet

Data Source: AFCEC, September 2012, MMR-AFCEC Data Warehouse
MMR Boundary from Massachusetts Air National Guard 2011

FIGURE 5-13D

LF-1 GROUNDWATER CONCENTRATION TRENDS

AFCEC - Massachusetts Military Reservation

Final 4th Five-Year Review, 2007-2012

CH2MHILL.

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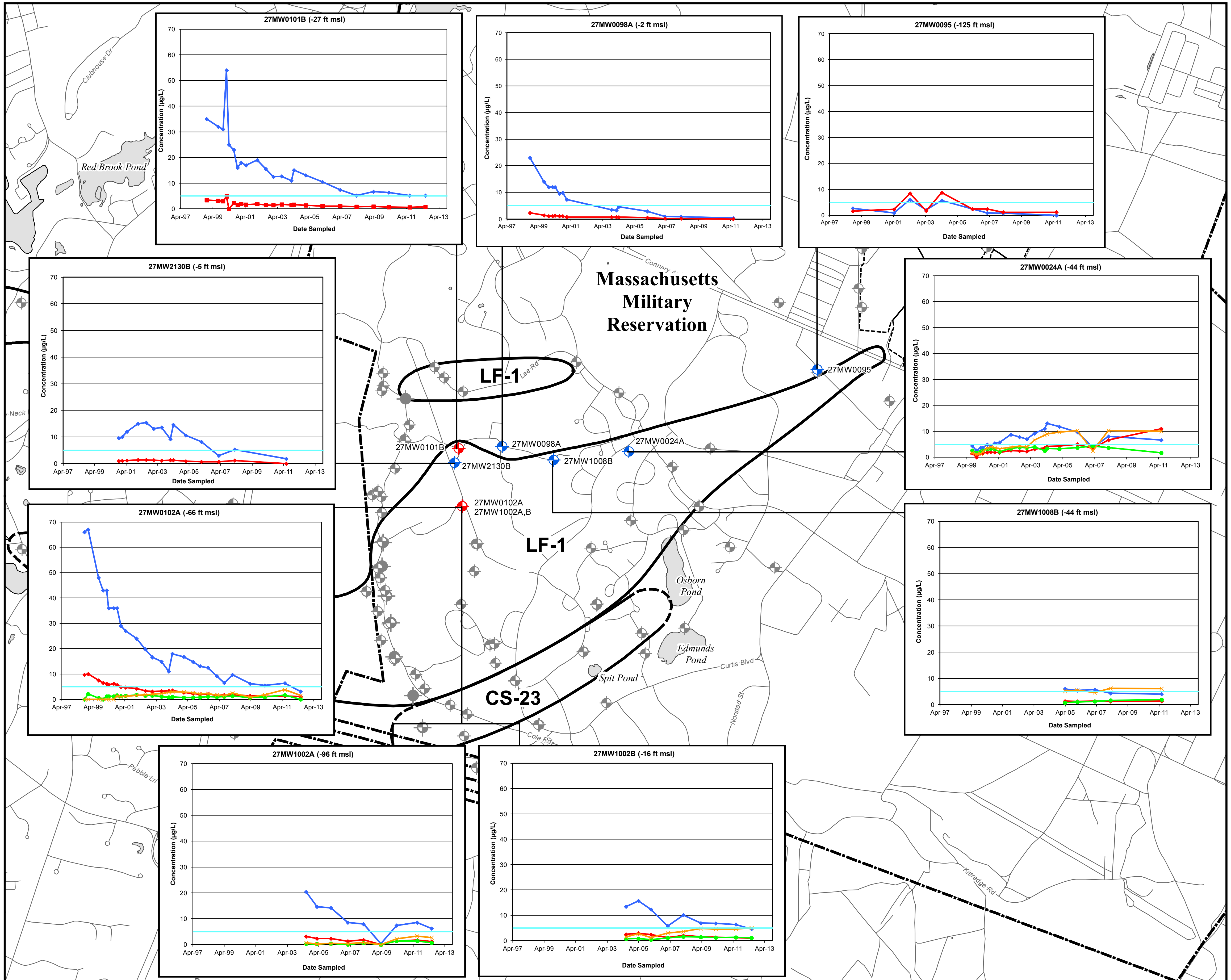

Legend

- Massachusetts Military Reservation Boundary
- Plume Boundary (Dashed Where Inferred)
- Landfill Cap Cell
- Monitoring Well (Triennial)
- Monitoring Well (Annual)
- PCE
- TCE
- VC
- 1,4-DCB
- PCE, TCE, CCl_4, MCL and 1,4-DCB MMCL = 5 µg/L

N

0 1,000 2,000 Feet

Data Source: AFCEC, September 2012, MMR-AFCEC Data Warehouse
MMR Boundary from Massachusetts Air National Guard 2011

FIGURE 5-13E

LF-1 GROUNDWATER CONCENTRATION TRENDS

AFCEC - Massachusetts Military Reservation

Final 4th Five Year Review, 2007-2012

CH2MHILL.

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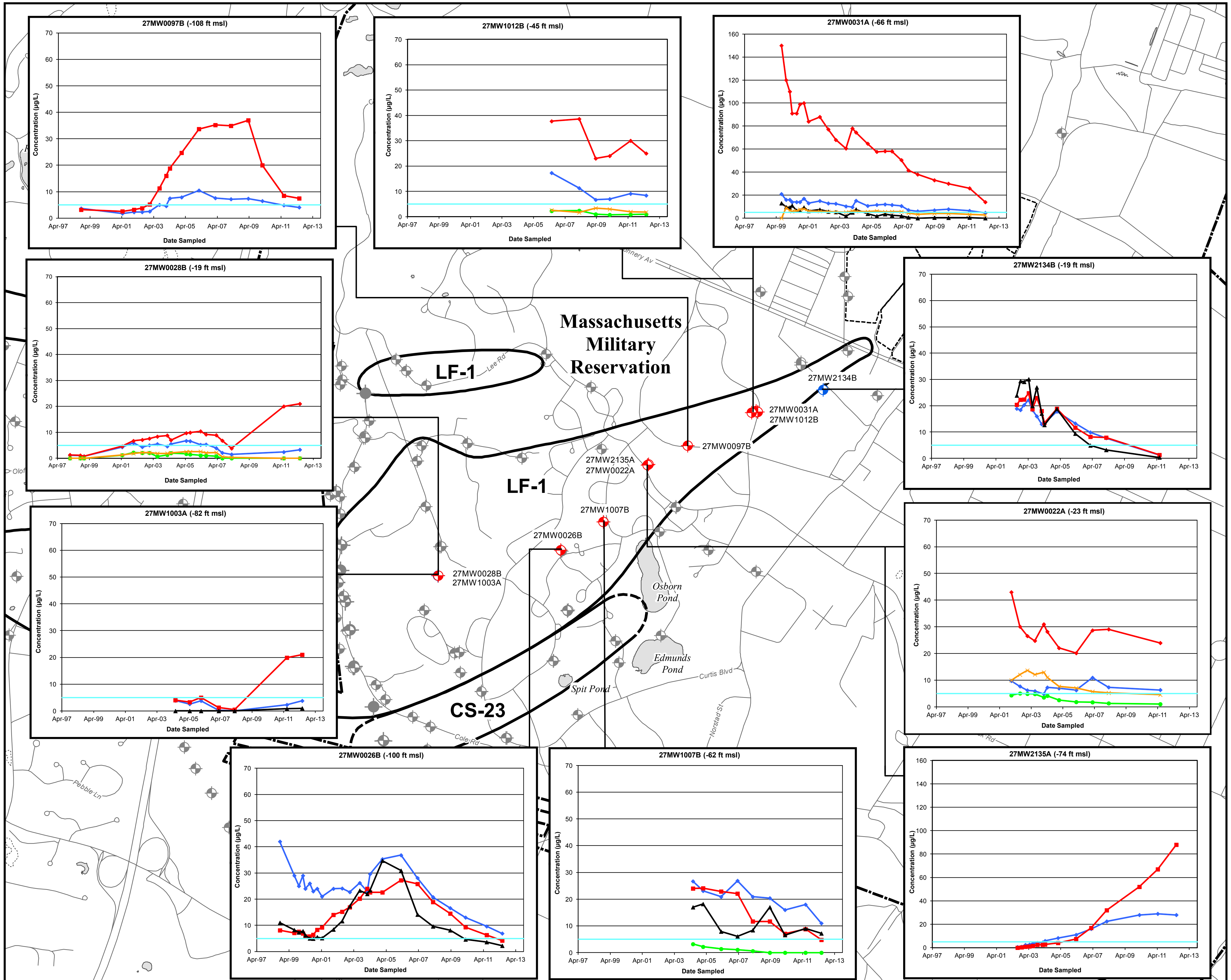

Legend

- Massachusetts Military Reservation Boundary
- Plume Boundary (Dashed Where Inferred)
- Landfill Cap Cell
- Monitoring Well (Triennial)
- Monitoring Well (Annual)
- PCE
- TCE
- CCl_4
- VC
- 1,4-DCB
- PCE, TCE, CCl_4 MCL and 1,4-DCB MMCL = 5 µg/L

0 980 1,960 Feet

Data Source: AFCEC, September 2012, MMR-AFCEC Data Warehouse
MMR Boundary from Massachusetts Air National Guard 2011

FIGURE 5-13F

LF-1 GROUNDWATER CONCENTRATION TRENDS

AFCEC - Massachusetts Military Reservation

Final 4th Five Year Review, 2007-2012

CH2MHILL.

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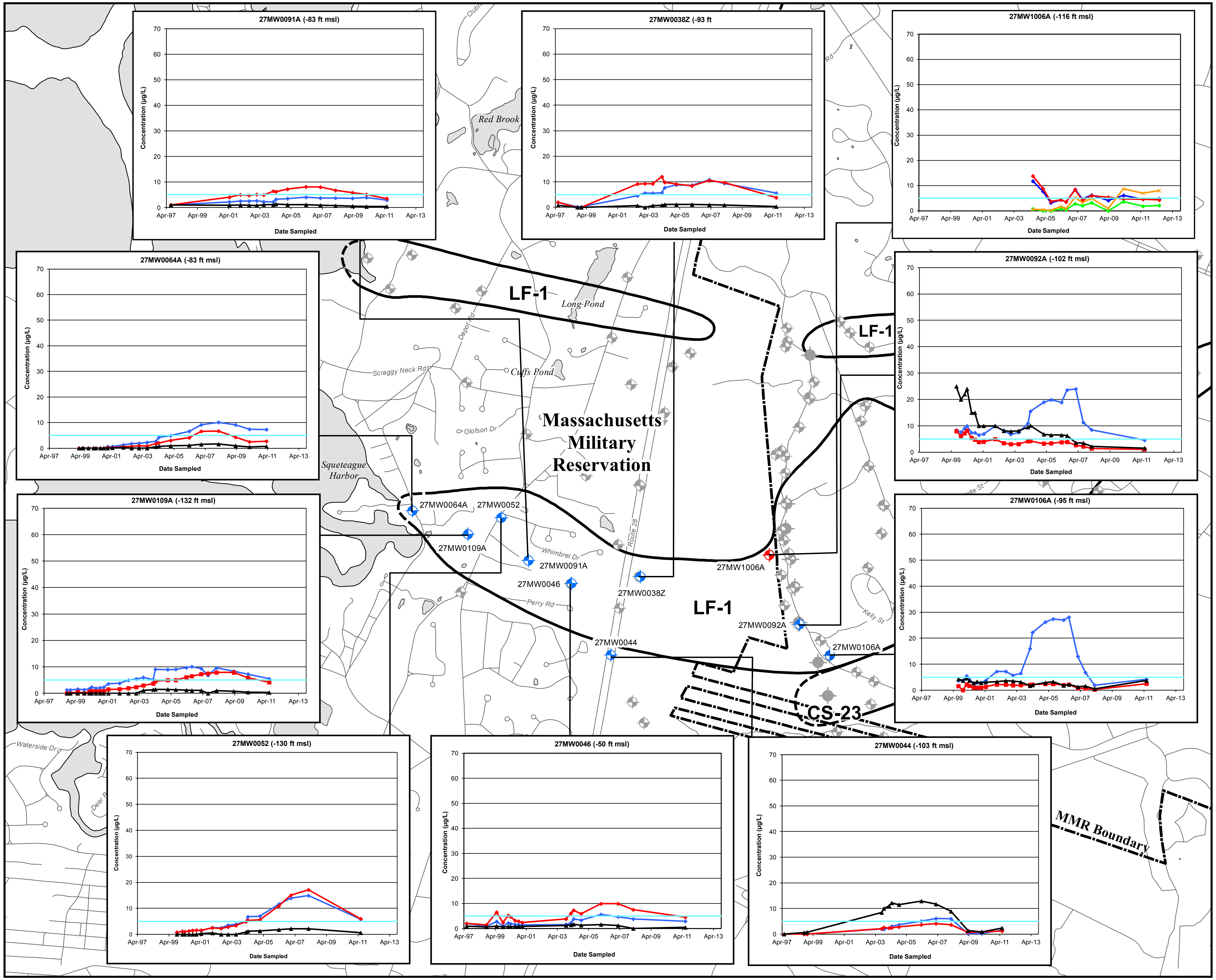

Legend

Massachusetts Military Reservation Boundary

Plume Boundary (Dashed Where Inferred)

Monitoring Well (Triennial)

Monitoring Well (Annual)

PCE

TCE

CCl_4

VC

1,4-DCB

PCE, TCE, CCl_4, MCL and 1,4-DCB MMCL = 5 µg/L

N

0 875 1,750 Feet

Data Source: AFCEC, September 2012, MMR-AFCEC Data Warehouse
MMR Boundary from Massachusetts Air National Guard 2011

FIGURE 5-13G

LF-1 GROUNDWATER CONCENTRATION TRENDS

AFCEC - Massachusetts Military Reservation

Final 4th Five Year Review, 2007-2012

CH2MHILL.

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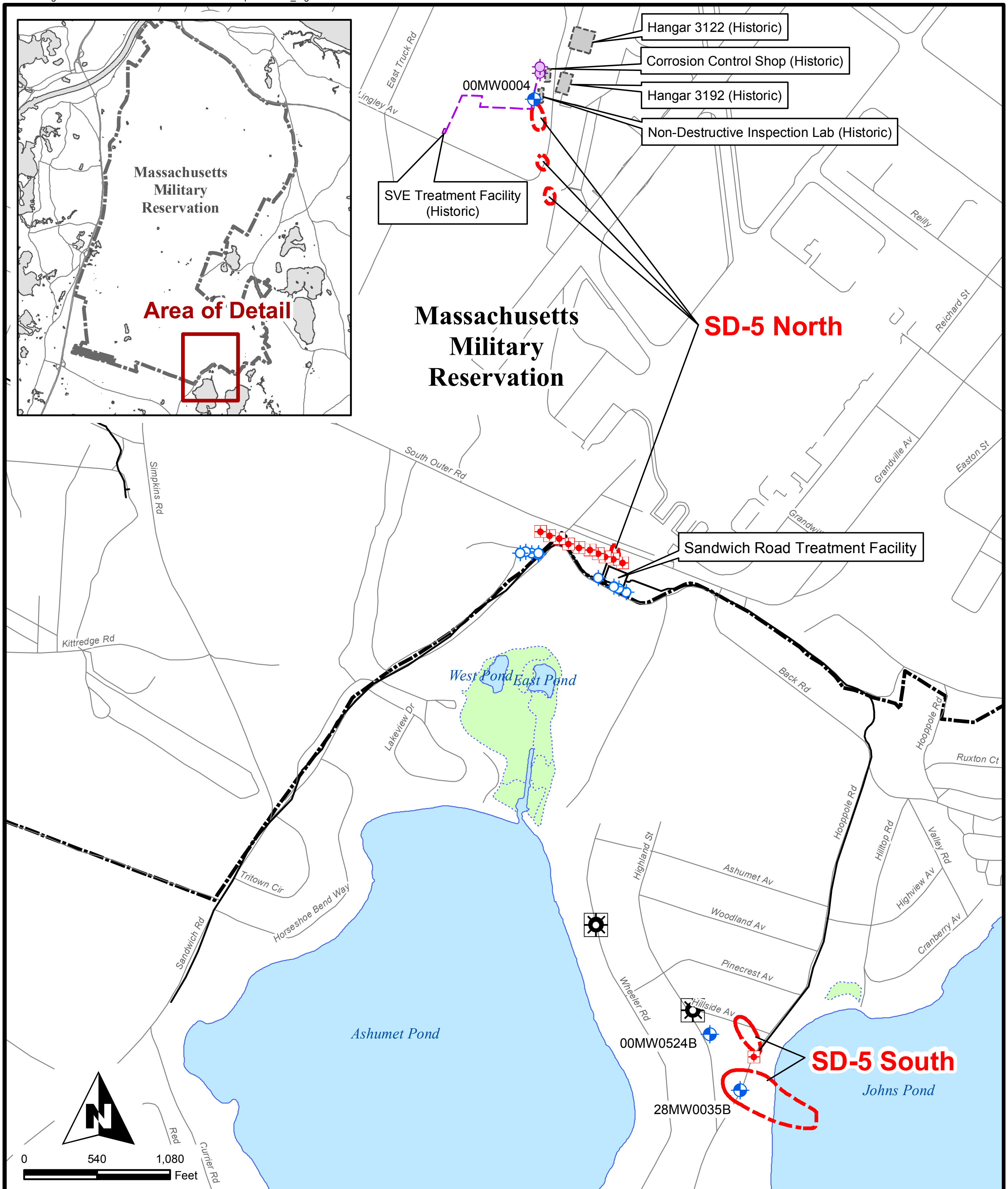

Legend

- Massachusetts Military Reservation Boundary
- SD-5 2005 Plume Boundary (Dashed Where Inferred)
- Bog/Wetland
- Historic Building Site

Data Source: AFCEC, April 2013, MMR-AFCEC Data Warehouse

- Historic SVE Pipeline
- Historic SVE Extraction Well
- Reinjection Well (On)
- Extraction Well (Off)
- Recirculating Well (Abandoned)
- Monitoring Well

FIGURE 5-14A

SD-5 GROUNDWATER PLUME (2005 DELINEATION)

AFCEC - Massachusetts Military Reservation

Final 4th Five-Year Review, 2007-2012

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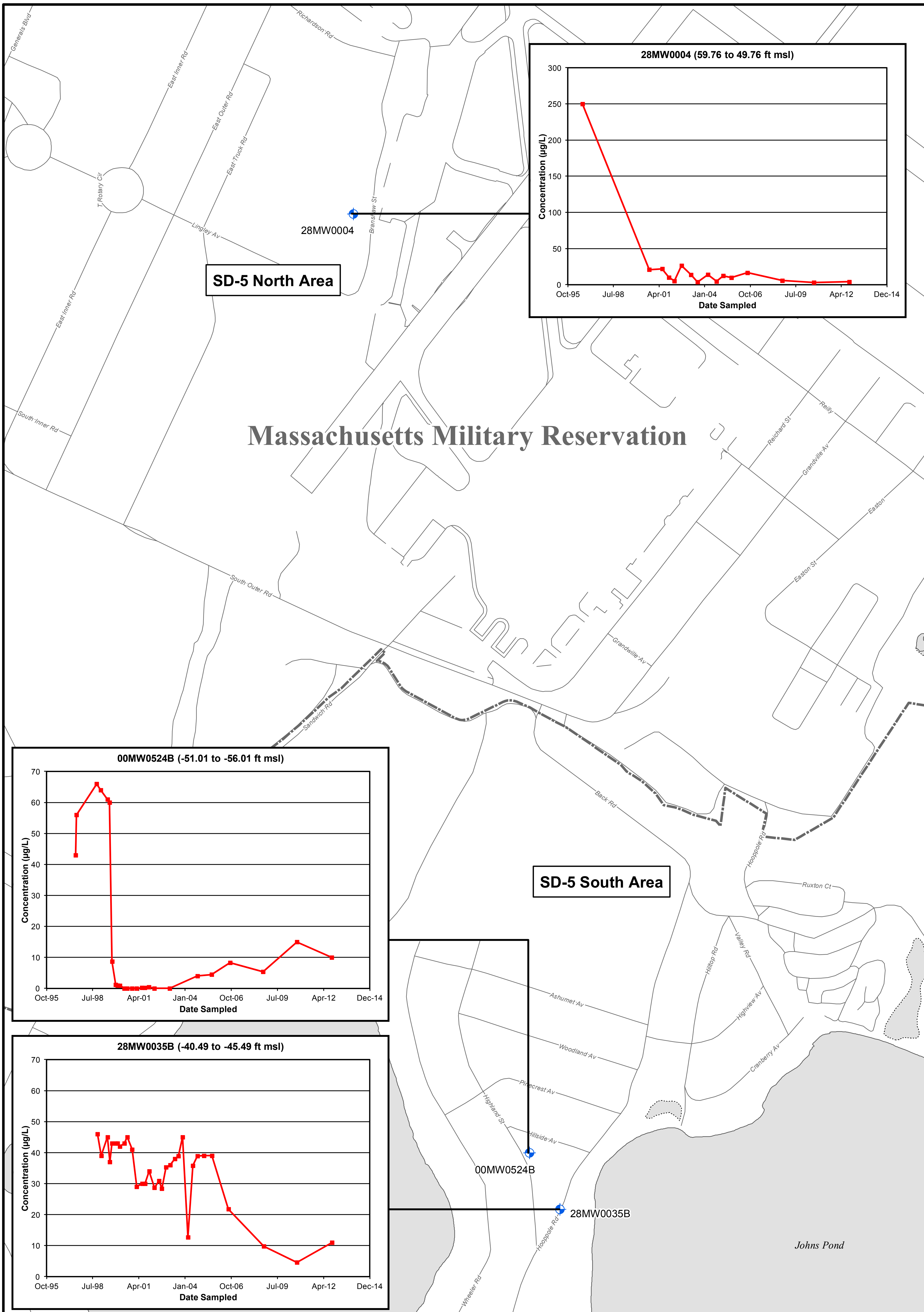

Data Source: AFCEC, November 2012, MMR-AFCEC Data Warehouse

Legend

- Massachusetts Military Reservation Boundary
- Monitoring Well
- TCE

0 340 680 Feet

FIGURE 5-14B

SD-5 GROUNDWATER CONCENTRATION TRENDS

AFCEC - Massachusetts Military Reservation

Final 4th Five-Year Review, 2007-2012

TABLES

Table 1-1a
IRP Source Area Sites No Longer Requiring a Five Year Review
Final 4th Five-Year Review, 2007-2012

IRP Source Area Site	Reference Document	Summary rationale why UU/UE was appropriate and/or why Five-Year Reviews are no longer required
CS-18	*Final CS-18 Soil Removal Action Report* (AFCEE 2009a)	Since site is on active range and may have munitions of explosive concern remaining, the site is not UU/UE. No additional action is planned under CERCLA and any training related munitions or residual sources may be addressed under EPA Safe Drinking Water Act Administrative Orders or other future range clean-up activities.
CS-19	*Final CS-19 Soil Removal Action Report* (AFCEE 2009b)	Since site is on active range and may have munitions of explosive concern remaining, the site is not UU/UE. No additional action is planned under CERCLA and any training related munitions or residual sources may be addressed under EPA Safe Drinking Water Act Administrative Orders or other future range clean-up activities.
FS-1	*Explanation of Significant Differences Areas of Contamination CS-10/FS-24, FS-1, and FS-9* (AFCEE 2011)	The delineation sampling results for SVOCs and pesticide support unrestricted use of FS-1 source soils relative to the current MCP S-1/GW-1 (MassDEP 2012) and EPA (2012) residential based RSLs.
FS-9*	*Explanation of Significant Differences Areas of Contamination CS-10/FS-24, FS-1, and FS-9* (AFCEE 2011)	The delineation and post-excavation confirmation sampling results for metals and EPH/VPH support unrestricted use of FS-9 source soils relative to the current MCP S-1/GW-1 (MassDEP 2012) and EPA residential based RSLs (EPA 2012).
CS-1*	*Decision Document Technical Memorandum* (AFCEC 2013a)	The delineation and post-excavation sampling results for VOCs, SVOCs, PAHs, pesticides/PCBs, and inorganics support unrestricted use of surface and subsurface soils at CS-1 relative to the current RALs, MCP S-1/GW-1 standards (MassDEP 2012), and EPA residential based RSLs (EPA 2012).
CS-14	*Decision Document Technical Memorandum* (AFCEC 2013a)	The post-excavation sampling results for methylene chloride support unrestricted use of surface and subsurface soils at CS-14, relative to the current MCP S-1/GW-1 standards (MassDEP 2012) and EPA residential based RSLs (EPA 2012).
CS-15	*Decision Document Technical Memorandum* (AFCEC 2013a)	The characterization and post-excavation sampling results for VOCs, SVOCs, PAHs, pesticides/PCBs, and inorganics support unrestricted use of subsurface soils at CS-15 relative to the current RALs, MCP S-1/GW-1 standards (MassDEP 2012), and EPA residential RSLs (EPA 2012). However, the dieldrin concentrations in the drainage ditch southwest of the former gas trap (SD-1 and SD-2) were determined in 1989 to exceed current MCP standards. Reported loss rates for dieldrin in soils and sediments range from 3 to 25 years for 75 to 100 percent loss (EPA 2003). Based on the 22-year period between the sampling in 1989 and the present, concentrations would be expected to be significantly lower. AFCEC plans to re-sample sediment at locations SD-1 and SD-2 for analysis of dieldrin to confirm whether CS-15 meets unlimited use/unrestricted exposure (UU/UE) conditions.
CS-2CG	*Decision Document Technical Memorandum* (AFCEC 2013a)	The characterization and post-excavation sampling results for PAHs support UU/UE of surface and subsurface soils at CS-2 CG relative to the current MCP S-1/GW-1 standards (MassDEP 2012) and EPA residential RSLs (EPA 2012).
CS-6*	*Decision Document Technical Memorandum* (AFCEC 2013a)	The characterization sampling results for SVOCs, pesticides/PCBs, and inorganics support unrestricted use of subsurface soils at CS-6 relative to the current MCP S-1/GW-1 standards (MassDEP 2012) and EPA residential RSLs (EPA 2012).

Table 1-1a
IRP Source Area Sites No Longer Requiring a Five Year Review
Final 4th Five-Year Review, 2007-2012

IRP Source Area Site	Reference Document	Summary rationale why UU/UE was appropriate and/or why Five-Year Reviews are no longer required
CS-6CG	*Decision Document Technical Memorandum* (AFCEC 2013a)	The characterization and post-excavation sampling results for VOCs, SVOCs, PAHs, pesticides/PCBs, and inorganics support UU/UE of surface and subsurface soils at CS-6 CG relative to the current MCP S-1/GW-1 standards (MassDEP 2012) and EPA residential based RSLs (EPA 2012).
CY-1*	*Decision Document Technical Memorandum* (AFCEC 2013a)	The characterization sampling results for inorganics support unrestricted use of subsurface soils at CY-1 relative to the current RALs, MCP S-1/GW-1 standards (MassDEP 2012), and EPA residential based RSLs (EPA 2012).
CY-3	*Decision Document Technical Memorandum* (AFCEC 2013a)	The characterization sampling results for inorganics support unrestricted use of subsurface soils at CY-3 relative to the current RALs, MCP S-1/GW-1 standards (MassDEP 2012), and EPA residential based RSLs (EPA 2012).
FS-22*	*Decision Document Technical Memorandum* (AFCEC 2013a)	The characterization sampling results for SVOCs, pesticides/PCBs, and inorganics support unrestricted use of subsurface soils at FS-22 relative to the current MCP S-1/GW-1 standards (MassDEP 2012) and EPA residential based RSLs (EPA 2012).
FS-25	*Decision Document Technical Memorandum* (AFCEC 2013a)	The post-excavation confirmation sampling results for metals and petroleum hydrocarbons support unrestricted use of FS-25 soils relative to the current RALs, the current MCP S-1/GW-1 standards (MassDEP 2012), and EPA residential based RSLs (EPA 2012).
FS-2CG*	*Decision Document Technical Memorandum* (AFCEC 2013a)	The characterization sampling results for VOCs, SVOCs, and inorganics support unrestricted use of subsurface soils at FS-2CG relative to the current RALs, MCP S-1/GW-1 standards (MassDEP 2012), and EPA residential based RSLs (EPA 2012).
FS-3	*Decision Document Technical Memorandum* (AFCEC 2013a)	The characterization sampling results for VOCs and inorganics support unrestricted use of subsurface soils at FS-3 relative to the current MCP S-1/GW-1 standards (MassDEP 2012) and EPA residential based RSLs (EPA 2012).
SD-1*	*Decision Document Technical Memorandum* (AFCEC 2013a)	The characterization sampling results for SVOCs, pesticides/PCBs, and inorganics support unrestricted use of subsurface soils at SD-1 relative to the current MCP S-1/GW-1 standards (MassDEP 2012) and EPA residential based RSLs (EPA 2012).
CS-11*	*Action Memorandum Technical Memorandum* (AFCEC 2013b)	The post-excavation confirmation sampling results for metals and the primary COC dieldrin support unrestricted use of CS-11 soils relative to the AM addendum RALs, the current MCP S-1/GW-1 standards (MassDEP 2012), and EPA residential based RSLs (EPA 2012).
CS-4CG	*Action Memorandum Technical Memorandum* (AFCEC 2013b)	The delineation and post-excavation confirmation sampling results for residual PAHs and metals support unrestricted use of CS-4 CG surface and subsurface soils relative to the AM and AM addendum RALs, the current MCP S-1/GW-1 standards and background values (MassDEP 2012). Results for COCs present at concentrations above background also support unrestricted use relative to EPA residential based RSLs (EPA 2012).
CS-5*	*Action Memorandum Technical Memorandum* (AFCEC 2013b)	The delineation and post-excavation confirmation sampling results for aliphatic and aromatic petroleum hydrocarbon fractions, aroclor-1242, and lead were below RALs established in the AM addendum to be protective of human health and the environment for all exposure scenarios. Concentrations are also lower than current MCP S-1/GW-1 standards (MassDEP 2012) and the EPA Region 9 RSL for lead (EPA 2011). EPA Region 9 RSLs are not available for petroleum hydrocarbons.

Table 1-1a
IRP Source Area Sites No Longer Requiring a Five Year Review
Final 4th Five-Year Review, 2007-2012

IRP Source Area Site	Reference Document	Summary rationale why UU/UE was appropriate and/or why Five-Year Reviews are no longer required
DDOU	*Action Memorandum Technical Memorandum* (AFCEC 2013b)	The delineation and post-excavation confirmation sampling results for SVOCs, metals and pesticides support unrestricted use of DDOU surface and subsurface soils relative to the AM RALs, MMR background values, and the current MCP S-1/GW-1 standards (MassDEP 2012) and EPA residential based RSLs (EPA 2012).
FS-12	*Action Memorandum Technical Memorandum* (AFCEC 2013b)	The post-treatment residual exposure point concentrations for all hydrocarbon fractions and ethylbenzene are below the AM RALs, the current MCP S-3/GW-1 and S-3/GW-3 standards (MassDEP 2012), and EPA residential based RSLs (EPA 2012).
FS-18*	*Action Memorandum Technical Memorandum* (AFCEC 2013b)	The delineation and post-excavation confirmation sampling results for petroleum hydrocarbons support unrestricted use of FS-18 surface and subsurface soils relative to the AM RALs and current MCP S-1/GW-1 standards (MassDEP 2012).
FS-1CG	*Action Memorandum Technical Memorandum* (AFCEC 2013b)	The delineation and post-excavation confirmation sampling results for residual PAHs and metals support unrestricted use of FS-1 CG surface and subsurface soils relative to the AM and AM addendum RALs, the current MCP S-1/GW-1 standards (MassDEP 2012), and background values. Results for COCs present at concentrations above background also support unrestricted use relative to EPA residential based RSLs (EPA 2012).
FS-4	*Action Memorandum Technical Memorandum* (AFCEC 2013b)	The remedial design sampling results for petroleum hydrocarbons support unrestricted use of FS-4 surface and subsurface soils relative to the AM RALs, current MCP S-1/GW-1 standards (MassDEP 2012), and EPA residential based RSLs (EPA 2012).
FS-7*	*Action Memorandum Technical Memorandum* (AFCEC 2013b)	The delineation and post-excavation confirmation sampling results for PAHs support unrestricted use of FS-7 surface and subsurface soils relative to the AM and AM addendum RALs and the current MCP S-1/GW-1 standards and background values (MassDEP 2012).
FTA-1*	*Action Memorandum Technical Memorandum* (AFCEC 2013b)	The post-excavation confirmation sampling results for VOCs and petroleum hydrocarbons support unrestricted use of FTA-1 surface and subsurface soils relative to the STCLs, current MCP S-1/GW-1 standards (MassDEP 2012), and EPA residential based RSLs (EPA 2012).
CS-16*	*Chemical Spill-16/Chemical Spill-17 Technical Memorandum* (AFCEC 2013c)	The delineation and post-excavation confirmation sampling results for metals and pesticides/PCBs support unrestricted use of CS-16 surface and subsurface soils relative to the ROD and ESD RALs, the current MCP S-1/GW-1 standards (MassDEP 2012), and EPA residential based RSLs (EPA 2012).
CS-17*	*Chemical Spill-16/Chemical Spill-17 Technical Memorandum* (AFCEC 2013c)	The delineation and post-excavation confirmation sampling results for metals and pesticides/PCBs support unrestricted use of CS-17 surface and subsurface soils relative to the 2003 ESD and 2013 ESD RALs, the current MCP S-1/GW-1 standards (MassDEP 2012), and EPA residential based RSLs (EPA 2012).
CY-4	*Six Area of Concern Technical Memorandum* (AFCEC 2013d)	The delineation and post-excavation confirmation sampling results for metals, SVOCs and PCBs support unrestricted use of CY-4 surface and subsurface soils relative to the 2003 ESD and 2013 ESD RALs, the current MCP S-1/GW-1 standards (MassDEP 2012), and EPA residential based RSLs (EPA 2012).
FS-5	*Six Area of Concern Technical Memorandum* (AFCEC 2013d)	The delineation and post-excavation confirmation sampling results for metals, VOCs and petroleum hydrocarbons support unrestricted use of FS-5 surface and subsurface soils relative to the 2003 ESD and 2013 ESD RALs, the current MCP S-1/GW-1 standards (MassDEP 2012), and EPA residential based RSLs (EPA 2012).

Table 1-1a
IRP Source Area Sites No Longer Requiring a Five Year Review
Final 4th Five-Year Review, 2007-2012

IRP Source Area Site	Reference Document	Summary rationale why UU/UE was appropriate and/or why Five-Year Reviews are no longer required
FS-6	*Six Area of Concern Technical Memorandum* (AFCEC 2013d)	The delineation and post-excavation confirmation sampling results for metals support unrestricted use of FS-6 surface and subsurface soils relative to the 2003 ESD RALs, the current MCP S-1/GW-1 standards (MassDEP 2012), and EPA residential based RSLs (EPA 2012).
FS-8	*Six Area of Concern Technical Memorandum* (AFCEC 2013d)	The delineation and post-excavation confirmation sampling results for metals support unrestricted use of FS-8 surface and subsurface soils relative to the 2003 ESD RALs, the current MCP S-1/GW-1 standards (MassDEP 2012), and EPA residential based RSLs (EPA 2012).
FTA-3	*Six Area of Concern Technical Memorandum* (AFCEC 2013d)	The delineation and post-excavation confirmation sampling results for metals, SVOCs and PCBs support unrestricted use of FTA-3 surface and subsurface soils relative to the 2003 ESD and 2013 ESD RALs, the current MCP S-1/GW-1 standards (MassDEP 2012), and EPA residential based RSLs (EPA 2012).
SD-2	*Six Area of Concern Technical Memorandum* (AFCEC 2013d)	The delineation and post-excavation confirmation sampling results for metals support unrestricted use of SD-2 surface and subsurface soils relative to the 2003 ESD RALs, the current MCP S-1/GW-1 standards (MassDEP 2012), and EPA residential based RSLs (EPA 2012).
SD-3	*Six Area of Concern Technical Memorandum* (AFCEC 2013d)	The delineation and post-excavation confirmation sampling results for metals, SVOCs and PCBs support unrestricted use of SD-3 surface and subsurface soils relative to the 2003 ESD and 2013 ESD RALs, the current MCP S-1/GW-1 standards (MassDEP 2012), and EPA residential based RSLs (EPA 2012).
SD-5	*Six Area of Concern Technical Memorandum* (AFCEC 2013d)	The delineation and post-excavation confirmation sampling results for metals, VOCs and petroleum hydrocarbons support unrestricted use of SD-5 surface and subsurface soils relative to the 2003 ESD and 2013 ESD RALs, the current MCP S-1/GW-1 standards (MassDEP 2012), and EPA residential based RSLs (EPA 2012).

Note:
* Source area site falls within CS-10 groundwater plume boundary where land use controls restricting groundwater use are in place.

Key:
AFCEC = Air Force Civil Engineer Center
AFCEE = Air Force Center for Engineering and the Environment
AM = Action Memorandum
CERCLA = Comprehensive Environmental Response, Compensation, and Liability Act
COC = contaminant of concern
CG = U.S. Coast Guard
CS = Chemical Spill
CY = Coal Yard
DDOU = Drum Disposal Operable Unit
EPA = U.S. Environmental Protection Agency
EPH/VPH = extractable/volatile petroleum hydrocarbons
ESD = Explanation of Significant Differences
FS = Fuel Spill
FTA = Fire Training Area
IRP = Installation Restoration Program
MassDEP = Massachusetts Department of Environmental Protection
MCP = Massachusetts Contingency Plan
MMR = Massachusetts Military Reservation

PAH = polycyclic aromatic hydrocarbon
PCB = polychlorinated biphenyl
RAL = remedial action level
ROD = Record of Decision
RSL = Regional Screening Level
S-1/GW-1 = surface water-1/ groundwater-1
S-3/GW-1 = surface water-3/ groundwater-1
S-3/GW-3 = surface water-3/ groundwater-3
SD = Storm Drain
SVOC = semivolatile organic compound
UU/UE = unlimited use and unrestricted exposure
VOC = volatile organic compound

References:

AFCEC. 2013a (in preparation). *Decision Document Technical Memorandum*. Prepared by AFCEC/MMR, Installation Restoration Program, Otis Air National Guard Base, MA

______. 2013b (in preparation). *Action Memorandum Technical Memorandum.* Prepared by AFCEC/MMR, Installation Restoration Program, Otis Air National Guard Base, MA

______. 2013c (in preparation). *Chemical Spill-16/Chemical Spill-17 Technical Memorandum.* Prepared by AFCEC/MMR, Installation Restoration Program, Otis Air National Guard Base, MA

______. 2013d (in preparation). *Six Area of Concern Technical Memorandum*. Prepared by AFCEC/MMR, Installation Restoration Program, Otis Air National Guard Base, MA

AFCEE. 2011 (September). *Explanation of Significant Differences Areas of Contamination CS-10/FS-24, FS-1, and FS-9*, *Massachusetts Military Reservation (MMR) Superfund Sit*e, Otis Air National Guard Base, MA.

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______. 2009b (September). *Final CS-19 Soil Removal Action Report.* Prepared by ECC for AFCEE/MMR, Installation Restoration Program, Otis Air National Guard Base, MA.

EPA. 2012. *Regional Screening Level (RSL) Resident Soil Supporting Table*, May 2012, http://www.epa.gov/region9/superfund/prg/, Web page accessed May 2012.

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______. 2003. *Health Effects Support Document for Aldrin/Dieldrin,* http://nepis.epa.gov/EPA/html/DLwait.htm?url=/Adobe/PDF/20003JSU.PDFer/, EPA 822-R-03-001, February 2003.

MassDEP. 2012, *MCP Method 1 Soil and Groundwater Standards*, 310 CMR 40.0975(6) (a), http://www.mass.gov/dep/cleanup/laws/0975_6a.htm. Web page accessed May 2012.

Table 1-1b
Summary of All IRP Source Area Sites No Longer Requiring a Five Year Review
Final 4th Five Year Review, 2007-2012

IRP Source Area Site	Reference Document
2nd Five Year Review	
CS-2	2nd Five Year Review (1998-2002), AFCEE 2003
CS-3	2nd Five Year Review (1998-2002), AFCEE 2003
CS-3 CG	2nd Five Year Review (1998-2002), AFCEE 2003
CS-5CG	2nd Five Year Review (1998-2002), AFCEE 2003
CS-7	2nd Five Year Review (1998-2002), AFCEE 2003
CS-7 CG	2nd Five Year Review (1998-2002), AFCEE 2003
CS-8	2nd Five Year Review (1998-2002), AFCEE 2003
CS-9	2nd Five Year Review (1998-2002), AFCEE 2003
CS-10 Tank Wash OU	2nd Five Year Review (1998-2002), AFCEE 2003
CS-12	2nd Five Year Review (1998-2002), AFCEE 2003
FS-2	2nd Five Year Review (1998-2002), AFCEE 2003
FS-14	2nd Five Year Review (1998-2002), AFCEE 2003
FS-15	2nd Five Year Review (1998-2002), AFCEE 2003
FS-16	2nd Five Year Review (1998-2002), AFCEE 2003
FS-17	2nd Five Year Review (1998-2002), AFCEE 2003
FS-19	2nd Five Year Review (1998-2002), AFCEE 2003
FS-20	2nd Five Year Review (1998-2002), AFCEE 2003
FS-21	2nd Five Year Review (1998-2002), AFCEE 2003
FS-23	2nd Five Year Review (1998-2002), AFCEE 2003
FS-26	2nd Five Year Review (1998-2002), AFCEE 2003
FS-27	2nd Five Year Review (1998-2002), AFCEE 2003
LF-1 CG	2nd Five Year Review (1998-2002), AFCEE 2003
LF-2 CG	2nd Five Year Review (1998-2002), AFCEE 2003
LF-3	2nd Five Year Review (1998-2002), AFCEE 2003
LF-3 CG	2nd Five Year Review (1998-2002), AFCEE 2003
LF-4	2nd Five Year Review (1998-2002), AFCEE 2003
LF-5	2nd Five Year Review (1998-2002), AFCEE 2003
LF-6	2nd Five Year Review (1998-2002), AFCEE 2003
3rd Five Year Review	
CS-1 CG	3rd Five Year Review (2002-2007), AFCEE 2008
CS-4	3rd Five Year Review (2002-2007), AFCEE 2008
CS-8 CG	3rd Five Year Review (2002-2007), AFCEE 2008
CS-22	3rd Five Year Review (2002-2007), AFCEE 2008
FS-13	3rd Five Year Review (2002-2007), AFCEE 2008
4th (current) Five Year Review	
CS-1	4th (current) Five Year Review (2007-2012)
CS-11	4th Five Year Review (2007-2012)
CS-14	4th Five Year Review (2007-2012)
CS-15	4th Five Year Review (2007-2012)
CS-16	4th Five Year Review (2007-2012)
CS-17	4th Five Year Review (2007-2012)
CS-18	4th Five Year Review (2007-2012)
CS-19	4th Five Year Review (2007-2012)
CS-2 CG	4th Five Year Review (2007-2012)
CS-4 CG	4th Five Year Review (2007-2012)
CS-5	4th Five Year Review (2007-2012)
CS-6	4th Five Year Review (2007-2012)
CS-6 CG	4th Five Year Review (2007-2012)
CY-1	4th Five Year Review (2007-2012)
CY-3	4th Five Year Review (2007-2012)
CY-4	4th Five Year Review (2007-2012)
DDOU	4th Five Year Review (2007-2012)
FS-1	4th Five Year Review (2007-2012)
FS-1 CG	4th Five Year Review (2007-2012)
FS-2 CG	4th Five Year Review (2007-2012)
FS-3	4th Five Year Review (2007-2012)
FS-4	4th Five Year Review (2007-2012)
FS-5	4th Five Year Review (2007-2012)
FS-6	4th Five Year Review (2007-2012)
FS-7	4th Five Year Review (2007-2012)

Table 1-1b
Summary of All IRP Source Area Sites No Longer Requiring a Five Year Review
Final 4th Five Year Review, 2007-2012

IRP Source Area Site	Reference Document
FS-8	4th Five Year Review (2007-2012)
FS-9	4th Five Year Review (2007-2012)
FS-12	4th Five Year Review (2007-2012)
FS-18	4th Five Year Review (2007-2012)
FS-22	4th Five Year Review (2007-2012)
FS-25	4th Five Year Review (2007-2012)
FTA-1	4th Five Year Review (2007-2012)
FTA-3	4th Five Year Review (2007-2012)
SD-1	4th Five Year Review (2007-2012)
SD-2	4th Five Year Review (2007-2012)
SD-3	4th Five Year Review (2007-2012)
SD-5	4th Five Year Review (2007-2012)

Key:
COC = contaminant of concern
CG = U.S. Coast Guard
CS = Chemical Spill
CY = Coal Yard
DDOU = Drum Disposal Operable Unit
FS = Fuel Spill
FTA = Fire Training Area
IRP = Installation Restoration Program
MMR = Massachusetts Military Reservation
OU = operable unit
SD = Storm Drain

Air Force Center for Engineering and the Environment (AFCEE) 2003 (May). Final 2nd Five-Year Review, 1998-2002 Massachusetts Military Reservation (MMR) Superfund Site, Otis Air National Guard Base, MA. Prepared by AFCEE/MMR and Portage Environmental, Inc. for AFCEE/MMR, Installation Restoration Program, Otis ANG Base, MA.

AFCEE 2008 (September). Final 3rd Five-Year Review, 2002-2007 Massachusetts Military Reservation (MMR) Superfund Site, Otis Air National Guard Base, MA. Prepared by Engineering Strategies Corporation, Portage and CH2M HILL for AFCEE/MMR, Installation Restoration Program, Otis ANG Base, MA.

Table 1-2
Decision Summary of Source Area Sites Addressed in this Five-Year Review
Final 4th Five-Year Review, 2007-2012

IRP Number or Site Name	Final Decision Document			ESDs or Amendments?	Remedy Components
	Title	Issue Date	AR #		
CS-10/FS-24 (Details C and F)	Record of Decision Area of Contamination CS-10/FS-24 Source Areas	1999	12435	2003 ESD 2011 ESD	Detail C: Soil Vapor Extraction System Detail F: Institutional Controls (TBD)
LF-1	Final Record of Decision for the LF-1 Source Area and Groundwater	2007	18664	2013a ESD	Landfill Cap and Institutional Controls
FTA-2/LF-2	Record of Decision for Areas of Contamination FTA-2/LF-2, PFSA/FS-10/FS-11, SD-2/FS-6/FS-8, SD-3/FTA-3/CY-4, and SD-5/FS-5 Source Areas	1998	11609	none	Biosparge Treatment System and Institutional Controls
LF-7	Decision Document Radar Tube Burial Landfill (LF-7 Study Area)	1993	8	none	Institutional Controls
PFSA (FS-10/FS-11)	Record of Decision for Areas of Contamination FTA-2/LF-2, PFSA/FS-10/FS-11, SD-2/FS-6/FS-8, SD-3/FTA-3/CY-4, and SD-5/FS-5 Source Areas	1998	11609	none	Biosparge Vapor Recover Treatment System and Institutional Controls
SD-4	Record of Decision for Areas of Contamination FTA-2/LF-2, PFSA/FS-10/FS-11, SD-2/FS-6/FS-8, SD-3/FTA-3/CY-4, and SD-5/FS-5 Source Areas	1998	11609	2013b ESD	Excavation/Asphalt Batching (not implemented)

Key:
AR = Administrative Record (legacy number at MMR)
CS = Chemical Spill
ESD = Explanation of Significant Differences
FS = Fuel Spill
FTA-2 = Fire Training Area 2
IRP = Installation Restoration Program
LF = Landfill
PFSA = Petroleum Fuel Storage Area
SD = Storm Drain
TBD = To Be Determined
UU/UE = unlimited use/unrestricted exposure

2013a ESD = AFCEC. 2013 (anticipated July). *Final Explanation of Significant Differences for the Landfill-1 (LF-1) Source Area at the Massachusetts Military Reservation*. 437075-SPEIM-LF1-ESD-001. Prepared by CH2M HILL for AFCEC/MMR, Installation Restoration Program, Otis Air National Guard Base, MA.

2013b ESD = AFCEC. 2013 (May). *Draft Explanation of Significant Differences for Areas of Contamination CS-16/CS-17, SD-3/ FTA-3/CY-4, SD-4, and SD-5/FS-5.* Prepared by Portage, Inc. for AFCEC/MMR.

2011 ESD = AFCEE. 2011 (September). *Explanation of Significant Differences Areas of Contamination CS-10/FS-24, FS-1, and FS-9*, *Massachusetts Military Reservation (MMR) Superfund Site*, Otis Air National Guard Base, MA.

2003 ESD = AFCEE. 2003a (February). *Explanation of Significant Differences Areas of Contamination CS-10 (A, B, & E); CS-16/CS-17; FS-9; SD-2/FS-6/FS-8; and SD-3/FTA-3/CY-4*. Prepared by Portage Environmental Inc. and Engineering Strategies Corporation.

Table 1-3
Decision Summary of Groundwater Sites Addressed in this Five-Year Review
Final 4th Five-Year Review, 2007-2012

Site	Final Decision Document			ESDs or Amendments?	Remedy Components
	Title	Issue Date	AR #		
Ashumet Valley	Final Record of Decision for the Ashumet Valley Groundwater	2009	18977	2011 ESD	ETI/ETD, SPEIM, LUCs, MNA, 5YR, 3-STEP
CS-4	Final Record of Decision for the CS-4, CS-20, CS-21, and FS-13 Plumes	2000	13425	2008 ESD 2011 ESD	ETI, SPEIM, LUCs, MNA, 5YR, 3-STEP
CS-10	Final Record of Decision for Chemical Spill-10 Groundwater	2009	18995	2011 ESD	ETI/ETR, SPEIM, LUCs, MNA, 5YR, 3-STEP
CS-19	Final Chemical Spill-19 Record of Decision	2009	19039	2011 ESD	LTM, LUCs, MNA, 5YR, 3-STEP
CS-20	Final Record of Decision for the CS-4, CS-20, CS-21, and FS-13 Plumes	2000	13425	2008 ESD 2011 ESD	ETR, SPEIM, LUCs, MNA, 5YR, 3-STEP
CS-21	Final Record of Decision for the CS-4, CS-20, CS-21, and FS-13 Plumes	2000	13425	2008 ESD 2011 ESD	ETR, SPEIM, LUCs, MNA, 5YR, 3-STEP
CS-23	Final Record of Decision for Chemical Spill-23 Groundwater	2007	18665	2011 ESD	ETI, SPEIM, LUCs, MNA, 5YR, 3-STEP
FS-1*	Final Record of Decision Area of Contamination FS-1*	2000	13245	2011 ESD	ETD, SPEIM, LUCs, MNA, 5YR, 3-STEP
FS-12	Final Record of Decision for Fuel Spill-12 Groundwater	2006	18419	2011 ESD	ETR, SPEIM, LUCs, MNA, 5YR, 3-STEP
FS-13	Final Record of Decision for the CS-4, CS-20, CS-21, and FS-13 Plumes	2000	13425	2008 ESD 2011 ESD	LTM, LUCs, MNA, 5YR, 3-STEP
FS-28	Final Record of Decision for the Fuel Spill-28 and Fuel Spill-29 Plumes	2000	13649	2008 ESD 2011 ESD	ETD, SPEIM, LUCs, MNA, 5YR, 3-STEP
FS-29	Final Record of Decision for the Fuel Spill-28 and Fuel Spill-29 Plumes	2000	13649	2008 ESD 2011 ESD	ETI/ETR, SPEIM, LUCs, MNA, 5YR, 3-STEP
LF-1	Final Record of Decision for Landfill-1 Source Area and Groundwater	2007	18664	2011 ESD	ETI/ETR, SPEIM, LUCs, MNA, 5YR, 3-STEP
SD-5	Final Record of Decision for Groundwater at Eastern Briarwood, Western Aquafarm, and Storm Drain-5	2006	18420	2011 ESD	LTM, LUCs, MNA, 5YR, 3-STEP

Key:

AR = Administrative Record (legacy number at MMR)
CS = Chemical Spill
ESD = Explanation of Significant Differences
ETD = extraction, treatment, and discharge
ETI = extraction, treatment, and infiltration
ETR = extraction, treatment, and reinjection
FS = Fuel Spill
LF = Landfill
LUC = Land Use Control
MNA = monitored natural attenuation
SD = Storm Drain
SPEIM = system performance and ecological impact monitoring
3-STEP = Three-step process to achieve site closure
5YR = Five-Year Review

FS-1* The FS-1 remedial system conceptual layout presented in the Record of Decision was refined in the Final Fuel Spill-1 Wellfield Design Report (AFCEE 2001). In addition, the predicted aquifer restoration timeframe presented in the ROD (7 years after system startup) was updated in the wellfield design report to 15 years after system start up (i.e., 2018). Refer to section 5.8 for further details on the remedial progress at FS-1.

2011 ESD = AFCEE 2011 (September). *Final Explanation of Significant Differences for the Installation Restoration Program Groundwater Plumes at the Massachusetts Military Reservation.* 404929-SPEIM-MULTIPLE-RPT-001. Prepared by CH2M HILL for AFCEE/MMR, Installation Restoration Program, Otis Air National Guard Base, MA.

2008 ESD = AFCEE 2008 (September). *Final Explanation of Significant Differences for Chemical Spill-4, Chemical Spill-20, Chemical Spill-21, Fuel Spill-13, Fuel Spill-28, and Fuel Spill-29 Groundwater Plumes*. A4P-J23-35BC24VC-M26-0006. Prepared by Jacobs Engineering Group Inc. for AFCEE/MMR, Installation Restoration Program, Otis Air National Guard Base, MA.

Table 1-4
Issue Description and Recommendations/Follow-Up Actions
Final 4th Five-Year Review, 2007-2012

Site Name	Issue Description	Issue Summary	Recommendation/ Follow-Up Actions	Recommendation/Follow-Up Action Summary	Recommended Implementation Date (Start)	Responsible Party
Source Area Sites						
CS-10/FS-24 Detail C and F	LUC/long-term protectiveness	Residual contaminant concentrations remain in soils/sediments.	Reassess soil data for UU/UE.	Complete a reassessment of Detail C EPH/VPH data and Detail F PAH, PCB, inorganic data and pursue UU/UE closure. If UU/UE closure cannot be achieved, then document LUC plan in an ESD.	November 2016	AFCEC
	Exposure assessment	The VI exposure pathway has not been assessed.	Complete VI evaluation.	Complete evaluation to assess potential for VI exposure following new guidance for petroleum hydrocarbon release sites.	November 2013	AFCEC
FTA-2/LF-2	LUC/long-term protectiveness	Petroleum hydrocarbon-related contamination in groundwater was not directly addressed by the selected remedy presented in the ROD.	Submit Focused Feasibility Study	Prepare a Focused Feasibility Study to assess remedial alternatives for FTA-2 groundwater, submit a PP, and document the selected remedy in a ROD amendment. A component of the remedy for FTA-2 groundwater should include enforceable LUCs to ensure long-term protectiveness similar to the other IRP groundwater sites.	October 2013	AFCEC
	LUC/long-term protectiveness	Deed notification required per MassDEP Solid Waste Regulations (310 CMR 19.141)	File deed notification at Base Real Property Office to meet intent of 310 CMR 19.141 and document in ROD Amendment	A component of the institutional controls is to document the presence of a landfill at LF-2 through a deed notification per the MassDEP solid waste regulations (310 CMR 19.141). AFCEC, working with the base real estate office and the Commonwealth who owns the property, have been unable to determine whether a deed for this parcel is in existence. Therefore, the deed notification will be filed at the Base Real Property office which will meet the intent of the deed notification regulatory requirement. This action will be documented in the ROD Amendment for the FTA-2/LF-2 site.	January 2014	AFCEC
PFSA (FS-10/FS-11)	LUC/long-term protectiveness	Additional petroleum-related contamination in groundwater has been detected and further characterized since preparation of the ROD.	Submit Focused Feasibility Study.	Prepare a Focused Feasibility Study to assess remedial alternatives for PFSA groundwater, submit a PP, and document the selected remedy in a ROD amendment. A component of the remedy for PFSA groundwater should include enforceable LUCs to ensure long-term protectiveness similar to the other IRP groundwater sites	October 2013	AFCEC
	Exposure assessment	The VI exposure pathway should be re-assessed.	Complete VI evaluation.	Complete evaluation to assess potential for VI exposure following new guidance for petroleum hydrocarbon release sites.	January 2014	AFCEC
SD-4	LUC/long term protectiveness	Site data have been reassessed against updated RALs with the finding that UU/UE is supported for the majority of the SD-4 site. However, concentrations of inorganic compounds remain in soil and sediment above the updated RALs in the pond/wetland area (south of Reilly Road) and UU/UE conditions have not been met based on these data.	Prepare a RAR and ESD.	Prepare a RAR to document post-ROD actions completed at SD-4 and provide the basis for implementation of LUCs. Prepare an ESD to update RAOs and document the no further action decision based on post-ROD sampling and ecological risk analyses for current and future use for all areas except the pond/wetland area (south of Reilly Road) where LUCS are required for the remedy to be protective in the long-term.	October 2013	AFCEC
	Exposure assessment	The VI exposure pathway has not been assessed.	Complete VI evaluation.	Complete evaluation to assess potential for VI exposure.	November 2014	AFCEC

Table 1-4
Issue Description and Recommendations/Follow-Up Actions
Final 4th Five-Year Review, 2007-2012

Site Name	Issue Description	Issue Summary	Recommendation/ Follow-Up Actions	Recommendation/Follow-Up Action Summary	Recommended Implementation Date (Start)	Responsible Party
Groundwater Sites						
Ashumet Valley, CS-4, CS-10, CS-20, CS-21, CS-23, LF-1, and SD-5	Emerging contaminants	Emerging contaminants, specifically 1,4-dioxane and/or perfluorinated compounds (Ashumet Valley only)	Develop sampling and analysis plan	A sampling and analysis plan shall be submitted to the regulatory agencies to assess the possible presence of 1,4-dioxane (all listed plumes) and perfluorinated compounds (Ashumet Valley only).	October 2013 (1,4-dioxane); December 2014 (Perflourinated Compounds)	AFCEC
CS-4	Restoration timeframe discrepancy	The most recent groundwater model estimated restoration timeframe (2029) was longer than that presented in the ROD (2017). The prolonged restoration timeframe predicted by the groundwater model is the result of the retarded attenuation of PCE in a low hydraulic conductivity unit (where groundwater flow is minimal and field data indicate that PCE is not present), creating a modeling artifact that is commonly observed in MMR modeling results.	Re-run transport simulation and present results	In a manner similar to that performed at CS-20, the most recent CS-4 transport simulations will be re-run without loading PCE mass in low hydraulic conductivity units (where supported by data) to provide a more accurate and realistic estimated aquifer restoration timeframe.	May 2014	AFCEC
CS-10	Restoration timeframe discrepancy	The CS-10 CSM has changed since the ROD with an increase in the extent of TCE contamination in the In-Plume area. Preliminary transport modeling results indicate that the ROD restoration timeframe may not be achieved.	Submit draft ESD to document optimization of treatment system.	An optimization assessment of the CS-10 remedial system is underway which will assess the performance of the remedial system, determine whether operational improvements can be made, and update the restoration timeframe prediction for comparison to that presented in the ROD. An ESD presenting the updated CSM and the updated prediction for aquifer restoration timeframe will be completed.	March 2014	AFCEC
FS-12	Restoration timeframe discrepancy	The FS-12 CSM has changed since the ROD with an increase in the extent of EDB contamination in the core of the plume. Preliminary transport modeling results indicate that the ROD restoration timeframe may not be achieved, but the prolonged restoration timeframe may have resulted from using an outdated plume shell.	Update EDB plume shell and complete a remedial system optimization assessment.	An optimization assessment of the FS-12 remedial system will be performed with an updated EDB plume shell to evaluate the performance of the remedial system and assess/update the model-predicted restoration timeframe versus that presented in the ROD. If necessary at the conclusion of the optimization assessment, an ESD presenting the updated CSM and/or the updated prediction for aquifer restoration timeframe will be completed.	September 2013	AFCEC
LF-1/CS-23	Restoration timeframe discrepancy	The most recent groundwater model estimated restoration timeframe was longer than that presented in the ROD. The prolonged restoration timeframe may have resulted from using an outdated conservative plume shell.	Update plume shells and complete a remedial system optimization assessment.	An optimization assessment of the LF-1/CS-23 remedial system will be performed with updated plume shells to evaluate the performance of the remedial system and assess/update the model-predicted restoration timeframe versus that presented in the RODs. If necessary at the conclusion of the optimization assessment, an ESD presenting the updated prediction for aquifer restoration timeframe will be completed.	January 2014	AFCEC

Table 1-4
Issue Description and Recommendations/Follow-Up Actions
Final 4th Five-Year Review, 2007-2012

Site Name	Issue Description	Issue Summary	Recommendation/ Follow-Up Actions	Recommendation/Follow-Up Action Summary	Recommended Implementation Date (Start)	Responsible Party
	Increasing TCE concentration at CS-23 monitoring well	Increasing TCE concentrations observed at monitoring well 69MW1710A which is located downgradient and outside of the CS-23 remedial system capture zone	Re-assess plume boundary and LUC boundary and present results.	Re-assess plume boundary and LUC boundary based on June 2013 data as recommended in the *LF-1/CS-23 2012 Annual SPEIM Data Presentation Project Note*	October 2013	AFCEC
	Potential ecological impacts from system operation	Groundwater modeling predictions indicated potential drawdown of surface water levels at nearby wetlands/vernal pools.	Continue monitoring	Continue to collect ecological and hydrological data to assess the potential ecological impacts associated with the surface water drawdown due to operation of the LF-1/CS-23 remedial system.	Ongoing	AFCEC
SD-5	Restoration timeframe discrepancy	TCE concentrations have not yet consistently reached the MCL at SD-5 South as was expected at the time of remedy selection, primarily due to the presence of contamination in low hydraulic conductivity aquifer materials.	Prepare an ESD	An ESD will be prepared to update the aquifer restoration timeframe estimate for SD-5 South.	December 2013	AFCEC

Key:
AFCEC = Air Force Civil Engineer Center
CS = Chemical Spill
CSM = conceptual site model
CY = Coal Yard
EDB = ethylene dibromide
EE/CA = Engineering Evaluation/Cost Assessment
EPH = extractable petroleum hydrocarbon
ESD = explanation of significant difference
FS = Fuel Spill
FTA = Fire Training Area
IRP = Installation Restoration Program
LF = Landfill
LUC = Land Use Control
MassDEP = Massachusetts Department of Environmental Protection
MCL = Maximum Contaminant Level
PAH =polynuclear aromatic hydrocarbon
PCB = polychlorinated biphenyls
PCE = tetrachloroethene
PFSA = Petroleum Fuels Storage Area
PP = proposed plan
RAL = remedial action level
MMR = Massachusetts Military Reservation
RAO = Remedial Action Objective
RAR - remedial action report
ROD = Record of Decision
SD = Storm Drain
TCE = trichloroethene
VI = vapor intrusion
VPH =volatile petroleum hydrocarbon
UU/UE = unlimited use/unrestricted exposure

Table 1-5
Summary of Protectiveness Statements
Final 4th Five-Year Review, 2007-2012

Site Name	Section Number	Summary of Protectiveness Statement
Source Area Sites		
CS-10/FS-24 Detail A, B, D, E, G and H	4.1	**The remedies for CS-10/FS-24 source area Details A, B, D, E, G, H, and I are protective of human health and the environment.**
CS-10/FS-24 Detail C and F	4.1	**The remedies for CS-10/FS-24 source area Details C and F are protective of human health and the environment in the short-term under the current land use scenario**. However, for the remedies to be protective in the long-term it is recommended that existing site characterization data be re-evaluated to determine if UU/UE conditions have been met; if UU/UE closure cannot be supported for Details C and/or F, then either (i) conduct additional cleanup activities to levels that allow UU/UE; or (ii) issue a decision document implementing enforceable land use controls preventing uses for which the site may still pose an unacceptable risk under future uses that would ensure long-term protectiveness.
LF-1	4.3	**The remedy for the LF-1 source area is protective of human health and the environment.** Groundwater monitoring under the LF-1 SPEIM/LTM Program (discussed in Section 5.14) does not indicate the LF-1 source area is acting as a continuing source of groundwater contamination. Therefore, the landfill cap system at LF-1 is operating as expected. In addition, the LUCs are in place and are functioning as intended.
FTA-2/LF-2	4.4	**The remedy for the FTA-2/LF-2 source area is protective of human health and the environment in the short-term under the current land use scenario.** The remedy is protective in the short-term since access to the site is controlled by current flight line security measures which include fencing and 24-hour security that effectively limits potential human exposure to site contaminants. For the remedy to be protective in the long-term, it is recommended that additional remedial actions be implemented to address petroleum-related contamination in groundwater that was not directly addressed by the selected remedy presented in the ROD.
LF-7	4.5	**The remedy for the LF-7 source area is protective of human health and the environment.** The LUCs (i.e., fence and signage) at LF-7 are functioning as intended and the annual radiological surveys do not indicate the presence of radiation above background levels at the ground surface or at three feet above the ground surface within the fenced area. However, it is recommended that additional investigation and potentially remediation be completed at LF-7 with regards the presence of Radium-226 to determine whether the site can meet UU/UE site closure requirements.
PFSA (FS-10/FS-11)	4.6	**The remedy for the PFSA source area is protective of human health and the environment in the short-term under the current land use scenario.** The remedy is protective in the short-term since access to the site is controlled by current flight line security measures which include fencing and 24-hour security that effectively limits potential human exposure to site contaminants. Although groundwater contamination has been detected off-base, no private or municipal wells exist in the area and recent monitoring data indicate the contamination is not migrating any significant distance off base and municipal regulations are in place controlling exposure. For the remedy to be protective in the long-term, it is recommended that additional remedial actions be implemented to address petroleum-related contamination in groundwater that was not directly addressed by the selected remedy presented in the ROD.
SD-4	4.7	**The remedy for the SD-4 source area is protective of human health and the environment in the short-term under the current land use scenario.** Site data has been reassessed against updated RALs with the finding that UU/UE is supported for the majority of the SD-4 site. However, concentrations of inorganic compounds remain in soil and sediment above the updated RALs in the pond/wetland area (south of Reilly Road) and UU/UE conditions have not been met based on these data. This portion of the SD-4 site is located within installation boundaries and access to the area is unlikely due to its remoteness and nature (heavily vegetated wetland). However, institutional controls preventing uses for which the site may still pose an unacceptable risk should be implemented to ensure long-term protectiveness.

Table 1-5
Summary of Protectiveness Statements
Final 4th Five-Year Review, 2007-2012

Site Name	Section Number	Summary of Protectiveness Statement
Groundwater Sites		
AV	5.1	**The remedy for the AV groundwater plume is protective of human health and the environment.** The remedial systems are performing as expected. The LUCs are in place and are functioning as intended. Through the combination of the active treatment by the remedial systems and natural attenuation processes, groundwater cleanup levels are expected to be achieved within the timeframe approximated in the ROD which was considered reasonable given the particular circumstances of the site.
CS-4	5.2	**The remedy for the CS-4 groundwater plume is protective of human health and the environment.** The remedial system is performing as expected. The LUCs are in place and are functioning as intended. Through the combination of the active treatment by the remedial system and natural attenuation processes, groundwater cleanup levels are expected to be achieved within the timeframe approximated in the ROD which was considered reasonable given the particular circumstances of the site.
CS-10	5.3	**The remedy for the CS-10 groundwater plume is protective of human health and the environment.** The remedial system is performing as expected and the LUCs are in place and are functioning as intended. Through the combination of the active treatment by the remedial systems and natural attenuation processes, groundwater cleanup levels are expected to be achieved. However, due to a change in the CSM, the aquifer restoration timeframe may be longer than expected at the time of remedy selection and this will be further assessed. When an updated estimate of the aquifer restoration timeframe is available, it will be determined whether the RAO of restoring the aquifer in a reasonable timeframe is being met. Since the LUCs are in place and are functioning as intended to prevent exposure and there are no current plans to use the portion of the aquifer where CS-10 contamination is located for water supply, the remedy remains protective.
CS-19	5.4	**The remedy for the CS-19 groundwater plume is protective of human health and the environment.** Remediation is progressing as expected. The LUCs are in place and are functioning as intended. Through natural attenuation processes groundwater cleanup levels are expected to be achieved within the timeframe approximated in the ROD which was considered reasonable given the particular circumstances of the site.
CS-20	5.5	**The remedy for the CS-20 groundwater plume is protective of human health and the environment.** The remedial system is performing as expected. The LUCs are in place and are functioning as intended. Through the combination of the active treatment by the remedial system and natural attenuation processes, groundwater cleanup levels are expected to be achieved within the timeframe approximated in the ROD which was considered reasonable given the particular circumstances of the site.
CS-21	5.6	**The remedy for the CS-21 groundwater plume is protective of human health and the environment.** The remedial system is performing as expected. The LUCs are in place and are functioning as intended. Through the combination of the active treatment by the remedial system and natural attenuation processes, groundwater cleanup levels are expected to be achieved within the timeframe approximated in the ROD which was considered reasonable given the particular circumstances of the site.
CS-23	5.7	**The remedy for the CS-23 groundwater plume is protective of human health and the environment.** The remedial system is performing as expected. The LUCs are in place and are functioning as intended. Through the combination of the active treatment by the remedial systems and natural attenuation processes, groundwater cleanup levels are expected to be achieved within the timeframe approximated in the ROD which was considered reasonable given the particular circumstances of the site.
FS-1	5.8	**The remedy for the FS-1 groundwater plume is protective of human health and the environment.** The remedial system is performing as expected. The LUCs are in place and are functioning as intended. Through the combination of the active treatment by the remedial system and natural attenuation processes, groundwater cleanup levels are expected to be achieved within the timeframe approximated in the ROD, and revised in the Wellfield Design Report, which was considered reasonable given the particular circumstances of the site.

Table 1-5
Summary of Protectiveness Statements
Final 4th Five-Year Review, 2007-2012

Site Name	Section Number	Summary of Protectiveness Statement
FS-12	5.9	**The remedy for the FS-12 groundwater plume is protective of human health and the environment.** The remedial system is performing as expected and the LUCs are in place and are functioning as intended. Through the combination of the active treatment by the remedial systems and natural attenuation processes, groundwater cleanup levels are expected to be achieved. However, due to a change in the CSM, the aquifer restoration timeframe may be longer than expected at the time of remedy selection and this will be further assessed. When an updated estimate of the aquifer restoration timeframe is available, it will be determined whether the RAO of restoring the aquifer in a reasonable timeframe is being met. Since the LUCs are in place and are functioning as intended to prevent exposure and there are no current plans to use the portion of the aquifer where FS-12 contamination remains for water supply, the remedy remains protective.
FS-13	5.10	**The remedy for the FS-13 groundwater plume is protective of human health and the environment.** Remediation is progressing as expected. The LUCs are in place and are functioning as intended. Through natural attenuation processes, groundwater cleanup levels are expected to be reached over time and monitoring data indicate the contaminants are not migrating beyond the FS-13 area.
FS-28	5.11	**The remedy for the FS-28 groundwater plume is protective of human health and the environment.** The remedial system is performing as expected. The LUCs are in place and are functioning as intended. Through the combination of the active treatment by the remedial system and natural attenuation processes, groundwater cleanup levels are expected to be achieved within the timeframe approximated in the ROD, which was considered reasonable given the particular circumstances of the site.
FS-29	5.12	**The remedy for the FS-29 groundwater plume is protective of human health and the environment.** The remedial system performed for a shorter time than expected. The LUCs are in place and are functioning as intended. Now that active treatment no longer needed, groundwater cleanup levels are expected to be achieved through natural attenuation processes within the timeframe approximated in the ROD, which was considered reasonable given the particular circumstances of the site.
LF-1	5.13	**The remedy for the LF-1 groundwater plume is protective of human health and the environment.** The remedial system is performing as expected and the LUCs are in place and are functioning as intended. Through the combination of the active treatment by the remedial systems and natural attenuation processes, groundwater cleanup levels are expected to be achieved. However, there is some uncertainty in the model-predicted restoration timeframe that will be further assessed. When an updated estimate of the aquifer restoration timeframe is available, it will be determined whether the RAO of restoring the aquifer in a reasonable timeframe is being met. Since the LUCs are in place and are functioning as intended to prevent exposure and there are no current plans to use the portion of the aquifer where LF-1 contamination remains for water supply, the remedy remains protective.
SD-5	5.14	**The remedy for the SD-5 groundwater plume is protective of human health and the environment.** The LTM program is ongoing and the LUCs are in place and are functioning as intended. Through pre-ROD operation of the SD-5 remedial system and natural attenuation processes, groundwater cleanup levels have been achieved at SD-5 North and are expected to be achieved at SD-5 South. However, the timeframe to achieve aquifer restoration at SD-5 South will be longer than predicted in the ROD, primarily due to the presence of contamination in low hydraulic conductivity aquifer materials. Since the LUCs are in place and are functioning as intended and there are no current plans to use this portion of the aquifer for water supply, the remedy remains protective.

Key:

AV = Ashumet Valley
CS = Chemical Spill
CSM = conceptual site model
CY = Coal Yard
FS = Fuel Spill
FTA = Fire Training Area
LF = Landfill
LTM = long term monitoring
LUC = Land Use Control
PFSA = Petroleum Fuels Storage Area
RAL = remedial action level
RAO = remedial action objective
ROD = Record of Decision
SD = Storm Drain
SPEIM = System Performance and Ecological Impact Monitoring
UU/UE = unlimited use and unrestricted exposure

Table 1-6
EPA CERCLIS Operable Unit Number and Document Section
Final 4th Five-Year Review, 2007-2012

OU#	Site Name	Document Section
1	FS-12	5.9
2	CS-4	5.2
3	CS-3 (USCG)	NA
4	CS-1 (USCG)	NA
5	FTA-2/LF-2, PFSA/FS-10/FS-11, SD-2/ FS-6/FS-8, SD-3/FTA-3/CY-4, SD-4, and SD-5/FS-5	4.4, 4.6, 4.7
6	FS-1	5.8
7	LF-1 Landfill Cap	4.3
8	CS-10/FS-24 Source Area	4.1
9	Southwest Operable Unit	5.2, 5.5, 5.6, 5.10
10	FS-9	NA
11	CS-16/CS-17	NA
12	FS-17/FS-19	NA
13	SD-5 North	5.14
14	CS-10 Sandwich Road	5.3
15	Ashumet Valley Groundwater	5.1
16	LF-1 Groundwater	5.13
17	Eastern Briarwood	NA
18	Western Aquafarm	NA
19	FS-28 & FS-29	5.11 & 5.12
20	SD-5 South	5.14
21	CS-10 In-Plume	5.3
22	CS-10 Southwest	5.3
23	FS-2	NA
24	CS-19	5.4
25	CS-23	5.7

Key:
CERCLIS = Comprehensive Environmental Response, Compensation, and Liability Information System
CS = Chemical Spill
CY = Coal Yard
EPA = U.S. Environmental Protection Agency
FS = Fuel Spill
FTA = Fire Training Area
LF = Landfill
NA = Not applicable – Five Year Review not needed since site meets unrestricted use/unlimited exposure – (See Table 1-1b).
OU = Operable Unit
PFSA = Petroleum Fuel Storage Area
SD = Storm Drain
USCG = U.S. Coast Guard

Table 3-1
Summary of Site Inspections
Final 4th Five-Year Review, 2007-2012

IRP Source Area Site	Issues	Schedule for Corrective Actions	Responsible Party	Does Issue Affect Remedy Protectiveness?
CY-10	None	N/A	N/A	No
FTA-2/LF-2	None	N/A	N/A	No
LF-1*	None	N/A	N/A	No
LF-7*	None	N/A	N/A	No
PFSA	None	N/A	N/A	No
SD-4	None	N/A	N/A	No

* AFCEC will continue annual inspections at these sites as part of the Land Use Control program.

Key:
FTA = Fire Training Area
LF = Landfill
N/A = not applicable
PFSA = Petroleum Fuel Storage Area
SD = Storm Drain

Table 4-1
CS-10/FS-24 Detail C Source Area 2012 Soil Sample Results
Final 4th Five-Year Review, 2007-2012

Location	Date	Test	Matrix	Sample Interval (ft bgs)	Analyte	Result	DL	RL	Units	Qual	MCP S-1/GW-1	Exceedance? Y/N
03BH1000	7/5/2012	EPH	SO	7-10	C11-C22 AROMATIC HYDROCARBONS	ND	13,500	26,800	µg/kg	U	1,000,000	N
03BH1000	7/5/2012	EPH	SO	7-10	C19-C36 ALIPHATIC HYDROCARBONS	15,300	13,500	26,800	µg/kg	J	3,000,000	N
03BH1000	7/5/2012	EPH	SO	7-10	C9-C18 ALIPHATIC HYDROCARBONS	62,800	26,810	53,600	µg/kg		1,000,000	N
03BH1000	7/5/2012	VPH	SO	7-10	C5-C8 ALIPHATIC HYDROCARBONS	ND	1,020	2,050	µg/kg	U	100,000	N
03BH1000	7/5/2012	VPH	SO	7-10	C9-C10 AROMATIC HYDROCARBONS	1,650	512	1,020	µg/kg		100,000	N
03BH1000	7/5/2012	VPH	SO	7-10	C9-C12 ALIPHATIC HYDROCARBONS	2,020	1,020	2,050	µg/kg	J	1,000,000	N
03BH1000	7/6/2012	EPH	SO	10-13	C11-C22 AROMATIC HYDROCARBONS	ND	13,900	27,800	µg/kg	U	1,000,000	N
03BH1000	7/6/2012	EPH	SO	10-13	C19-C36 ALIPHATIC HYDROCARBONS	23,300	13,900	27,800	µg/kg	J	3,000,000	N
03BH1000	7/6/2012	EPH	SO	10-13	C9-C18 ALIPHATIC HYDROCARBONS	675,000	139,000	278,000	µg/kg		1,000,000	N
03BH1000	7/6/2012	VPH	SO	10-13	C5-C8 ALIPHATIC HYDROCARBONS	ND	1,150	2,300	µg/kg	U	100,000	N
03BH1000	7/6/2012	VPH	SO	10-13	C9-C10 AROMATIC HYDROCARBONS	3,580	575	1,150	µg/kg		100,000	N
03BH1000	7/6/2012	VPH	SO	10-13	C9-C12 ALIPHATIC HYDROCARBONS	4,630	1,150	2,300	µg/kg		1,000,000	N
03BH1000	7/6/2012	EPH	SO	13-16	C11-C22 AROMATIC HYDROCARBONS	33,700	13,400	26,800	µg/kg		1,000,000	N
03BH1000	7/6/2012	EPH	SO	13-16	C19-C36 ALIPHATIC HYDROCARBONS	78,000	13,400	26,800	µg/kg		3,000,000	N
03BH1000	7/6/2012	EPH	SO	13-16	C9-C18 ALIPHATIC HYDROCARBONS	**2,670,000**	670,000	1,340,000	µg/kg		1,000,000	**Y**
03BH1000	7/6/2012	VPH	SO	13-16	C5-C8 ALIPHATIC HYDROCARBONS	1,750	1,220	2,440	µg/kg	J	100,000	N
03BH1000	7/6/2012	VPH	SO	13-16	C9-C10 AROMATIC HYDROCARBONS	**163,000**	6,090	12,200	µg/kg		100,000	**Y**
03BH1000	7/6/2012	VPH	SO	13-16	C9-C12 ALIPHATIC HYDROCARBONS	225,000	12,200	24,400	µg/kg		1,000,000	N
03BH1001	7/6/2012	EPH	SO	7-10	C11-C22 AROMATIC HYDROCARBONS	ND	14,100	28,100	µg/kg	U	1,000,000	N
03BH1001	7/6/2012	EPH	SO	7-10	C19-C36 ALIPHATIC HYDROCARBONS	ND	14,100	28,100	µg/kg	U	3,000,000	N
03BH1001	7/6/2012	EPH	SO	7-10	C9-C18 ALIPHATIC HYDROCARBONS	ND	14,100	28,100	µg/kg	U	1,000,000	N
03BH1001	7/6/2012	VPH	SO	7-10	C5-C8 ALIPHATIC HYDROCARBONS	ND	1,140	2,280	µg/kg	U	100,000	N
03BH1001	7/6/2012	VPH	SO	7-10	C9-C10 AROMATIC HYDROCARBONS	1,210	571	1,140	µg/kg		100,000	N
03BH1001	7/6/2012	VPH	SO	7-10	C9-C12 ALIPHATIC HYDROCARBONS	1,150	1,140	2,280	µg/kg	J	1,000,000	N
03BH1001	7/9/2012	EPH	SO	10-13	C11-C22 AROMATIC HYDROCARBONS	ND	13,500	26,900	µg/kg	U	1,000,000	N
03BH1001	7/9/2012	EPH	SO	10-13	C19-C36 ALIPHATIC HYDROCARBONS	ND	13,500	26,900	µg/kg	U	3,000,000	N
03BH1001	7/9/2012	EPH	SO	10-13	C9-C18 ALIPHATIC HYDROCARBONS	15,700	13,500	26,900	µg/kg	J	1,000,000	N
03BH1001	7/9/2012	VPH	SO	10-13	C5-C8 ALIPHATIC HYDROCARBONS	ND	1,190	2,390	µg/kg	U	100,000	N
03BH1001	7/9/2012	VPH	SO	10-13	C9-C10 AROMATIC HYDROCARBONS	3,570	597	1,190	µg/kg		100,000	N
03BH1001	7/9/2012	VPH	SO	10-13	C9-C12 ALIPHATIC HYDROCARBONS	4,640	1,190	2,390	µg/kg		1,000,000	N
03BH1001	7/9/2012	EPH	SO	13-16	C11-C22 AROMATIC HYDROCARBONS	ND	13,300	26,500	µg/kg	U	1,000,000	N
03BH1001	7/9/2012	EPH	SO	13-16	C19-C36 ALIPHATIC HYDROCARBONS	20,800	13,300	26,500	µg/kg	J	3,000,000	N
03BH1001	7/9/2012	EPH	SO	13-16	C9-C18 ALIPHATIC HYDROCARBONS	765,000	265,000	530,000	µg/kg		1,000,000	N
03BH1001	7/9/2012	VPH	SO	13-16	C5-C8 ALIPHATIC HYDROCARBONS	ND	1,210	2,420	µg/kg	U	100,000	N
03BH1001	7/9/2012	VPH	SO	13-16	C9-C10 AROMATIC HYDROCARBONS	26,400	3,030	6,060	µg/kg		100,000	N
03BH1001	7/9/2012	VPH	SO	13-16	C9-C12 ALIPHATIC HYDROCARBONS	34,200	6,060	12,100	µg/kg		1,000,000	N

Table 4-1
CS-10/FS-24 Detail C Source Area 2012 Soil Sample Results
Final 4th Five-Year Review, 2007-2012

Location	Date	Test	Matrix	Sample Interval (ft bgs)	Analyte	Result	DL	RL	Units	Qual	MCP S-1/GW-1	Exceedance? Y/N
03BH1002	7/9/2012	EPH	SO	7-10	C11-C22 AROMATIC HYDROCARBONS	ND	13,200	26,200	µg/kg	U	1,000,000	N
03BH1002	7/9/2012	EPH	SO	7-10	C19-C36 ALIPHATIC HYDROCARBONS	ND	13,200	26,200	µg/kg	U	3,000,000	N
03BH1002	7/9/2012	EPH	SO	7-10	C9-C18 ALIPHATIC HYDROCARBONS	ND	13,200	26,200	µg/kg	U	1,000,000	N
03BH1002	7/9/2012	VPH	SO	7-10	C5-C8 ALIPHATIC HYDROCARBONS	ND	1,140	2,270	µg/kg	U	100,000	N
03BH1002	7/9/2012	VPH	SO	7-10	C9-C10 AROMATIC HYDROCARBONS	1,920	569	1,140	µg/kg		100,000	N
03BH1002	7/9/2012	VPH	SO	7-10	C9-C12 ALIPHATIC HYDROCARBONS	2,250	1,140	2,270	µg/kg	J	1,000,000	N
03BH1002	7/10/2012	EPH	SO	10-13	C11-C22 AROMATIC HYDROCARBONS	ND	13,200	26,400	µg/kg	U	1,000,000	N
03BH1002	7/10/2012	EPH	SO	10-13	C19-C36 ALIPHATIC HYDROCARBONS	ND	13,200	26,400	µg/kg	U	3,000,000	N
03BH1002	7/10/2012	EPH	SO	10-13	C9-C18 ALIPHATIC HYDROCARBONS	ND	13,200	26,400	µg/kg	U	1,000,000	N
03BH1002	7/10/2012	VPH	SO	10-13	C5-C8 ALIPHATIC HYDROCARBONS	ND	1,230	2,450	µg/kg	UJ	100,000	N
03BH1002	7/10/2012	VPH	SO	10-13	C9-C10 AROMATIC HYDROCARBONS	928	613	1,230	µg/kg		100,000	N
03BH1002	7/10/2012	VPH	SO	10-13	C9-C12 ALIPHATIC HYDROCARBONS	ND	1,230	2,450	µg/kg	UJ	1,000,000	N
03BH1002	7/10/2012	EPH	SO	13-16	C11-C22 AROMATIC HYDROCARBONS	ND	13,300	26,600	µg/kg	U	1,000,000	N
03BH1002	7/10/2012	EPH	SO	13-16	C19-C36 ALIPHATIC HYDROCARBONS	ND	13,300	26,600	µg/kg	U	3,000,000	N
03BH1002	7/10/2012	EPH	SO	13-16	C9-C18 ALIPHATIC HYDROCARBONS	ND	13,300	26,600	µg/kg	U	1,000,000	N
03BH1002	7/10/2012	VPH	SO	13-16	C5-C8 ALIPHATIC HYDROCARBONS	1,180	1,170	2,330	µg/kg	J	100,000	N
03BH1002	7/10/2012	VPH	SO	13-16	C9-C10 AROMATIC HYDROCARBONS	1,200	583	1,170	µg/kg		100,000	N
03BH1002	7/10/2012	VPH	SO	13-16	C9-C12 ALIPHATIC HYDROCARBONS	ND	1,170	2,330	µg/kg	U	1,000,000	N

Data Source: AFCEE, September 2012, MMR-AFCEE Data Warehouse

Notes:

Bold concentrations represent an exceedance of the MCP Method 1 S-1/GW-1 Standard.

There are no EPA RSL (Residential) standards for EPH/VPH carbon ranges.

EPH/VPH Analysis via Massachusetts Department of Environmental Protection Method.

MCP method 1 S-1/GW-1 standards from: http://www.mass.gov/dep/cleanup/laws/0975_6a.htm .

Key:

CS-10 = Chemical Spill-10
DL = detection limit
EPA = U.S. Environmental Protection Agency
EPH = extractable petroleum hydrocarbons
ft bgs = feet below ground surface
J = estimated value
MCP = Massachusetts Contingency Plan
ND = nondetect
RL = reporting limit
RSL = regional screening level
SO = soil
U = undetected
VPH = volatile petroleum hydrocarbons
µg/kg = micrograms per kilogram

Table 4-2
Summary of Detections in FTA-2 Groundwater
2011-2012
Final 4th Five-Year Review 2007-2012

Location	Date	Test	Matrix	Depth	Analyte	Result	RL	DL	Standard	Type	Exceedance Y/N?
						All units = µg/L					
05MW0002	12/21/2011	MADEPVP	WG	58	C5-C8 ALIPHATIC HYDROCARBONS	BRL	20	10	300	GW-1	N
	12/21/2011	SW8260B	WG	58	CHLOROFORM	BRL	1	0.2	50	GW-1	N
28MW0005	12/20/2011	SW8260B	WG	56	1,2,4-TRIMETHYLBENZENE	**32**	1	0.22	17	RBC	**Y**
	12/20/2011	SW8260B	WG	56	1,3,5-TRIMETHYLBENZENE (MESITYLENE)	**42**	1	0.2	17	RBC	**Y**
	12/20/2011	MADEPEP	WG	56	2-METHYLNAPHTHALENE	8.3	0.2	0.1	10	GW-1	N
	12/20/2011	MADEPVP	WG	56	C5-C8 ALIPHATIC HYDROCARBONS	**1430 J**	100	50	300	GW-1	**Y**
	12/20/2011	MADEPVP	WG	56	C9-C10 AROMATIC HYDROCARBONS	**694 J**	100	50	200	GW-1	**Y**
	12/20/2011	MADEPVP	WG	56	C9-C12 ALIPHATIC HYDROCARBONS	**701 J**	100	50	700	GW-1	**Y**
	12/20/2011	MADEPEP	WG	56	C9-C18 ALIPHATIC HYDROCARBONS	BRL	200	100	700	GW-1	N
	12/20/2011	SW8260B	WG	56	TOLUENE	BRL	1	0.2	1000	MCL	N
28MW0022	4/24/2012	MADEPVP	WG	52	C5-C8 ALIPHATIC HYDROCARBONS	BRL	20	10	300	GW-1	N
	1/3/2013	MADEPVP	WG	52	C5-C8 ALIPHATIC HYDROCARBONS	BRL	20	10	300	GW-1	N
	4/24/2012	MADEPVP	WG	52	C9-C12 ALIPHATIC HYDROCARBONS	BRL	20	10	700	GW-1	N
	1/3/2013	SW8260B	WG	52	CHLOROMETHANE	BRL	1	0.2	1000	GW-1	N
28MW0023	12/21/2011	MADEPVP	WG	61	C5-C8 ALIPHATIC HYDROCARBONS	264	20	10	300	GW-1	N
	1/3/2013	MADEPVP	WG	61	C5-C8 ALIPHATIC HYDROCARBONS	**407**	20	10	300	GW-1	**Y**
	1/3/2013	MADEPVP	WG	61	C9-C12 ALIPHATIC HYDROCARBONS	BRL	20	10	700	GW-1	N
	1/3/2013	SW8260B	WG	61	CHLOROMETHANE	BRL	1	0.2	1000	GW-1	N
28MW0104	12/20/2011	MADEPVP	WG	57	C5-C8 ALIPHATIC HYDROCARBONS	BRL	20	10	300	GW-1	N
	12/20/2011	SW8260B	WG	57	CHLOROFORM	2	1	0.2	50	GW-1	N
28MW0606B	12/20/2011	MADEPVP	WG	65.95	C5-C8 ALIPHATIC HYDROCARBONS	BRL	20	10	300	GW-1	N
	12/20/2011	SW8260B	WG	65.95	TETRACHLOROETHENE (PCE)	BRL	1	0.19	5	MCL	N
	12/20/2011	SW8260B	WG	65.95	TRICHLOROETHENE (TCE)	2.1	1	0.2	5	MCL	N
39MW0002	12/21/2011	SW8260B	WG	51.1	1,2,4-TRIMETHYLBENZENE	**1120**	20	4.4	17	RBC	**Y**
	12/19/2012	SW8260B	WG	51.1	1,2,4-TRIMETHYLBENZENE	**499**	20	4.4	17	RBC	**Y**
	12/21/2011	SW8260B	WG	51.1	1,3,5-TRIMETHYLBENZENE (MESITYLENE)	**494**	20	4	17	RBC	**Y**
	12/19/2012	SW8260B	WG	51.1	1,3,5-TRIMETHYLBENZENE (MESITYLENE)	**204**	20	4	17	RBC	**Y**
	12/21/2011	MADEPEP	WG	51.1	2-METHYLNAPHTHALENE	**28**	4	2	10	GW-1	**Y**
	12/21/2011	MADEPVP	WG	51.1	C5-C8 ALIPHATIC HYDROCARBONS	**4580 J**	400	200	300	GW-1	**Y**
	12/19/2012	MADEPVP	WG	51.1	C5-C8 ALIPHATIC HYDROCARBONS	**1810**	200	100	300	GW-1	**Y**
	12/21/2011	MADEPVP	WG	51.1	C9-C10 AROMATIC HYDROCARBONS	**4140**	400	200	200	GW-1	**Y**
	12/19/2012	MADEPVP	WG	51.1	C9-C10 AROMATIC HYDROCARBONS	**1930**	200	100	200	GW-1	**Y**
	12/21/2011	MADEPVP	WG	51.1	C9-C12 ALIPHATIC HYDROCARBONS	**5670**	400	200	700	GW-1	**Y**
	12/19/2012	MADEPVP	WG	51.1	C9-C12 ALIPHATIC HYDROCARBONS	**1310**	200	100	700	GW-1	**Y**
	12/21/2011	MADEPEP	WG	51.1	C9-C18 ALIPHATIC HYDROCARBONS	235	200	100	700	GW-1	N
	12/21/2011	SW8260B	WG	51.1	ETHYLBENZENE	559	20	4	700	MCL	N
	12/19/2012	SW8260B	WG	51.1	ETHYLBENZENE	256	20	4	700	MCL	N
	12/21/2011	SW8260B	WG	51.1	M,P-XYLENE (SUM OF ISOMERS)	2270	20	8	10000	MCL	N
	12/19/2012	SW8260B	WG	51.1	M,P-XYLENE (SUM OF ISOMERS)	1040	20	8	10000	MCL	N
	12/21/2011	MADEPEP	WG	51.1	NAPHTHALENE	125	4	2	140	GW-1	N
	12/21/2011	SW8260B	WG	51.1	O-XYLENE (1,2-DIMETHYLBENZENE)	688	20	4	10000	MCL	N
	12/19/2012	SW8260B	WG	51.1	O-XYLENE (1,2-DIMETHYLBENZENE)	300	20	4	10000	MCL	N
	12/21/2011	SW8260B	WG	51.1	TETRACHLOROETHENE (PCE)	BRL	1	0.19	5	MCL	N
	12/19/2012	SW8260B	WG	51.1	TETRACHLOROETHENE (PCE)	BRL	1	0.19	5	MCL	N
	12/21/2011	SW8260B	WG	51.1	TOLUENE	6.4	1	0.2	1000	MCL	N
	12/19/2012	SW8260B	WG	51.1	TOLUENE	1.4	1	0.2	1000	MCL	N
	12/21/2011	SW8260B	WG	51.1	TRICHLOROETHENE (TCE)	BRL	1	0.2	5	MCL	N
39MW0006	12/20/2011	MADEPVP	WG	57.3	C5-C8 ALIPHATIC HYDROCARBONS	BRL	20	10	300	GW-1	N
	12/20/2011	MADEPVP	WG	57.3	C9-C12 ALIPHATIC HYDROCARBONS	BRL	20	10	700	GW-1	N

Table 4-2
Summary of Detections in FTA-2 Groundwater
2011-2012
Final 4th Five-Year Review 2007-2012

Location	Date	Test	Matrix	Depth	Analyte	Result	RL	DL	Standard	Type	Exceedance Y/N?
						All units = µg/L					
39MW410A	12/20/2011	SW8260B	WG	49	1,2,4-TRIMETHYLBENZENE	**24**	1	0.22	17	RBC	**Y**
	12/19/2012	SW8260B	WG	49	1,2,4-TRIMETHYLBENZENE	**94**	2.5	0.55	17	RBC	**Y**
	12/20/2011	SW8260B	WG	49	1,3,5-TRIMETHYLBENZENE (MESITYLENE)	13	1	0.2	17	RBC	N
	12/19/2012	SW8260B	WG	49	1,3,5-TRIMETHYLBENZENE (MESITYLENE)	**25**	1	0.2	17	RBC	**Y**
	12/20/2011	MADEPEP	WG	49	2-METHYLNAPHTHALENE	4.4	0.2	0.1	10	GW-1	N
	12/20/2011	MADEPEP	WG	49	ACENAPHTHENE	1.9	0.2	0.1	20	GW-1	N
	12/20/2011	MADEPEP	WG	49	ACENAPHTHYLENE	2	0.2	0.1	30	GW-1	N
	12/20/2011	MADEPEP	WG	49	ANTHRACENE	BRL	0.2	0.1	30	GW-1	N
	12/20/2011	MADEPEP	WG	49	C11-C22 AROMATIC HYDROCARBONS	**262**	150	75	200	GW-1	**Y**
	12/19/2012	MADEPEP	WG	49	C11-C22 AROMATIC HYDROCARBONS	**238**	150	75	200	GW-1	**Y**
	12/20/2011	MADEPVP	WG	49	C5-C8 ALIPHATIC HYDROCARBONS	104	20	10	300	GW-1	N
	12/19/2012	MADEPVP	WG	49	C5-C8 ALIPHATIC HYDROCARBONS	**434 J**	20	10	300	GW-1	**Y**
	12/20/2011	MADEPVP	WG	49	C9-C10 AROMATIC HYDROCARBONS	**350**	20	10	200	GW-1	**Y**
	12/19/2012	MADEPVP	WG	49	C9-C10 AROMATIC HYDROCARBONS	**647**	50	25	200	GW-1	**Y**
	12/20/2011	MADEPVP	WG	49	C9-C12 ALIPHATIC HYDROCARBONS	379	20	10	700	GW-1	N
	12/19/2012	MADEPVP	WG	49	C9-C12 ALIPHATIC HYDROCARBONS	359	50	25	700	GW-1	N
	12/20/2011	MADEPEP	WG	49	C9-C18 ALIPHATIC HYDROCARBONS	BRL	200	100	700	GW-1	N
	12/20/2011	SW8260B	WG	49	cis-1,2-DICHLOROETHENE	1	1	0.2	70	MCL	N
	12/19/2012	SW8260B	WG	49	cis-1,2-DICHLOROETHENE	BRL	1	0.2	70	MCL	N
	12/20/2011	SW8260B	WG	49	ETHYLBENZENE	1.1	1	0.2	700	MCL	N
	12/19/2012	SW8260B	WG	49	ETHYLBENZENE	36	1	0.2	700	MCL	N
	12/20/2011	MADEPEP	WG	49	FLUORENE	1.5	0.2	0.1	30	GW-1	N
	12/20/2011	SW8260B	WG	49	M,P-XYLENE (SUM OF ISOMERS)	BRL	1	0.4	10000	MCL	N
	12/19/2012	SW8260B	WG	49	M,P-XYLENE (SUM OF ISOMERS)	78 J	1	0.4	10000	MCL	N
	12/20/2011	MADEPEP	WG	49	NAPHTHALENE	8.5	0.2	0.1	140	GW-1	N
	12/19/2012	SW8260B	WG	49	O-XYLENE (1,2-DIMETHYLBENZENE)	1	1	0.2	10000	MCL	N
	12/20/2011	MADEPEP	WG	49	PHENANTHRENE	0.5	0.2	0.1	40	GW-1	N
	12/20/2011	SW8260B	WG	49	TRICHLOROETHENE (TCE)	BRL	1	0.2	5	MCL	N

Data Source: AFCEC, June 2013, AFCEC-MMR Data Warehouse.

Notes:

1. MCLs from U.S. Environmental Protection Agency (EPA) web page, http://www.epa.gov/safewater/contaminants/index.html.
2. GW-1 = MassDEP MCP Method 1 Groundwater-1 Standards from MassDEP web page http://www.mass.gov/dep/cleanup/laws/0974_2.htm.
3. No federal or site-specific cleanup standard for either of the isomers of trimethylbenzene (TMB) have been developed. However, a risk-based concentration of 17 µg/L was established for the Fuel Spill-13 groundwater site (Final Record of Decision for the CS-4, CS-20, CS-21 and FS-13 Plumes, dated February 2000).
4. The standard for xylenes presented is the MCL for total xylenes. MCLs for individual isomers of xylene are not available.
5. This tables presents the detected compounds from two sampling events conducted at select FTA-2 monitoring wells between 2011 and 2012. All samples were analyzed for VOC (including TMBs) and EPH/VPH by MassDEP Method.

Bold values represent concentrations above the groundwater standard (i.e., MCL, RBC, or GW-1).

Key:

BRL = below reporting limit
CS = Chemical Spill
DL = detection limit
EPH = extractable petroleum hydrocarbons
FS = Fuel Spill
FTA-2 = Fire Training Area 2
GW-1 = Groundwater -1
J = estimated value
MassDEP = Massachusetts Department of Environmental Protection
MCL = Maximum Contaminant Level
MCP = Massachusetts Contingency Plan
RBC = risk based concentration
RL = reporting limit
TMB = trimethylbenzene
VPH = volatile petroleum hydrocarbons
VOC = volatile organic compound
WG = groundwater
µg/L = micrograms per liter

Table 4-3
Summary of Detections in PFSA Groundwater
2009-2011
Final 4th Five-Year Review 2007-2012

Location	Date	Test	Matrix	Depth (ft bgs)	Analyte	Result	DL	RL	Standard	Type	Exceedance? Y/N
						All units = µg/L					
24MW401A	1/7/2009	SW8260B	WG	57	1,2,4-TRIMETHYLBENZENE	14	0.26	2	17	RBC	N
	2/9/2010	SW8260B	WG	57	1,2,4-TRIMETHYLBENZENE	14	0.27	1	17	RBC	N
	1/7/2009	SW8260B	WG	57	1,3,5-TRIMETHYLBENZENE (MESITYLENE)	3.4	0.24	2	17	RBC	N
	2/9/2010	SW8260B	WG	57	1,3,5-TRIMETHYLBENZENE (MESITYLENE)	4.1	0.21	1	17	RBC	N
	1/7/2009	BNASIM	WG	57	2-METHYLNAPHTHALENE	2.8	0.5	0.5	10	GW-1	N
	2/9/2010	MADEPEP	WG	57	2-METHYLNAPHTHALENE	2.84	0.034	0.4	10	GW-1	N
	1/7/2009	MADEPVP	WG	57	C5-C8 ALIPHATIC HYDROCARBONS	70	30	30	300	GW-1	N
	2/9/2010	MADEPVP	WG	57	C5-C8 ALIPHATIC HYDROCARBONS	BRL	0.76	50	300	GW-1	N
	1/7/2009	MADEPVP	WG	57	C9-C10 AROMATIC HYDROCARBONS	**210**	20	20	200	GW-1	**Y**
	2/9/2010	MADEPVP	WG	57	C9-C10 AROMATIC HYDROCARBONS	93.3	1.2	50	200	GW-1	N
	1/7/2009	MADEPVP	WG	57	C9-C12 ALIPHATIC HYDROCARBONS	76	30	30	700	GW-1	N
	2/9/2010	MADEPVP	WG	57	C9-C12 ALIPHATIC HYDROCARBONS	59.9	1.54	50	700	GW-1	N
	2/9/2010	SW8260B	WG	57	M,P-XYLENE (SUM OF ISOMERS)	BRL	0.35	2	10,000	MCL	N
	1/7/2009	BNASIM	WG	57	NAPHTHALENE	0.59	0.5	0.5	140	GW-1	N
24MW402A	1/9/2009	SW8260B	WG	57	1,2,4-TRIMETHYLBENZENE	1.2	0.13	1	17	RBC	N
	2/5/2010	SW8260B	WG	57	1,2,4-TRIMETHYLBENZENE	11	0.27	1	17	RBC	N
	1/9/2009	SW8260B	WG	57	1,3,5-TRIMETHYLBENZENE (MESITYLENE)	BRL	0.12	1	17	RBC	N
	2/5/2010	MADEPEP	WG	57	2-METHYLNAPHTHALENE	1.11	0.034	0.4	10	GW-1	N
	1/9/2009	MADEPVP	WG	57	C9-C10 AROMATIC HYDROCARBONS	24	20	20	200	GW-1	N
	2/5/2010	MADEPVP	WG	57	C9-C10 AROMATIC HYDROCARBONS	61.2	1.2	50	200	GW-1	N
	1/9/2009	SW8260B	WG	57	ETHYLBENZENE	BRL	0.13	1	700	MCL	N
	2/5/2010	SW8260B	WG	57	ETHYLBENZENE	BRL	0.26	1	700	MCL	N
	1/9/2009	SW8260B	WG	57	M,P-XYLENE (SUM OF ISOMERS)	BRL	0.31	2	10,000	MCL	N
	1/9/2009	SW8260B	WG	57	O-XYLENE (1,2-DIMETHYLBENZENE)	BRL	0.15	1	10,000	MCL	N
	2/5/2010	SW8260B	WG	57	O-XYLENE (1,2-DIMETHYLBENZENE)	1.4	0.33	1	10,000	MCL	N
24MW403A	1/14/2009	SW8260B	WG	57	1,2,4-TRIMETHYLBENZENE	**32.1**	0.13	1	17	RBC	**Y**
	2/9/2010	SW8260B	WG	57	1,2,4-TRIMETHYLBENZENE	**62**	0.27	1	17	RBC	**Y**
	4/25/2011	SW8260B	WG	57	1,2,4-TRIMETHYLBENZENE	**58**	0.22	1	17	RBC	**Y**
	1/14/2009	SW8260B	WG	57	1,3,5-TRIMETHYLBENZENE (MESITYLENE)	9.5	0.12	1	17	RBC	N
	2/9/2010	SW8260B	WG	57	1,3,5-TRIMETHYLBENZENE (MESITYLENE)	17	0.21	1	17	RBC	N
	4/25/2011	SW8260B	WG	57	1,3,5-TRIMETHYLBENZENE (MESITYLENE)	17	0.2	1	17	RBC	N
	1/14/2009	BNASIM	WG	57	2-METHYLNAPHTHALENE	8.8	0.5	0.5	10	GW-1	N
	2/9/2010	MADEPEP	WG	57	2-METHYLNAPHTHALENE	**11.2**	0.034	0.4	10	GW-1	**Y**
	4/25/2011	MADEPEP	WG	57	2-METHYLNAPHTHALENE	**13**	0.1	0.2	10	GW-1	**Y**
	4/25/2011	MADEPEP	WG	57	C11-C22 AROMATIC HYDROCARBONS	103 J	74	149	200	GW-1	N
	1/14/2009	MADEPVP	WG	57	C5-C8 ALIPHATIC HYDROCARBONS	97	30	30	300	GW-1	N
	2/9/2010	MADEPVP	WG	57	C5-C8 ALIPHATIC HYDROCARBONS	93.2 J	1.52	100	300	GW-1	N
	4/25/2011	MADEPVP	WG	57	C5-C8 ALIPHATIC HYDROCARBONS	146	50	50	300	GW-1	N
	1/14/2009	MADEPVP	WG	57	C9-C10 AROMATIC HYDROCARBONS	**310**	20	20	200	GW-1	**Y**
	2/9/2010	MADEPVP	WG	57	C9-C10 AROMATIC HYDROCARBONS	**335**	2.4	100	200	GW-1	**Y**
	4/25/2011	MADEPVP	WG	57	C9-C10 AROMATIC HYDROCARBONS	**472**	20	20	200	GW-1	**Y**
	1/14/2009	MADEPVP	WG	57	C9-C12 ALIPHATIC HYDROCARBONS	110	30	30	700	GW-1	N
	2/9/2010	MADEPVP	WG	57	C9-C12 ALIPHATIC HYDROCARBONS	209	3.08	100	700	GW-1	N
	4/25/2011	MADEPVP	WG	57	C9-C12 ALIPHATIC HYDROCARBONS	429	20	20	700	GW-1	N
	1/14/2009	SW8260B	WG	57	ETHYLBENZENE	BRL	0.13	1	700	MCL	N
	2/9/2010	SW8260B	WG	57	ETHYLBENZENE	BRL	0.26	1	700	MCL	N
	4/25/2011	SW8260B	WG	57	ETHYLBENZENE	BRL	0.2	1	700	MCL	N
	2/9/2010	MADEPEP	WG	57	FLUORENE	BRL	0.022	0.4	30	GW-1	N
	4/25/2011	MADEPEP	WG	57	FLUORENE	0.26	0.1	0.2	30	GW-1	N
	1/14/2009	SW8260B	WG	57	M,P-XYLENE (SUM OF ISOMERS)	BRL	0.31	2	10,000	MCL	N
	2/9/2010	SW8260B	WG	57	M,P-XYLENE (SUM OF ISOMERS)	4.2	0.35	2	10,000	MCL	N
	4/25/2011	SW8260B	WG	57	M,P-XYLENE (SUM OF ISOMERS)	4.1	0.4	1	10,000	MCL	N
	1/14/2009	BNASIM	WG	57	NAPHTHALENE	1.4	0.5	0.5	140	GW-1	N
	2/9/2010	MADEPEP	WG	57	NAPHTHALENE	2.01	0.02	0.4	140	GW-1	N
	4/25/2011	MADEPEP	WG	57	NAPHTHALENE	2.2	0.1	0.2	140	GW-1	N
	1/14/2009	SW8260B	WG	57	O-XYLENE (1,2-DIMETHYLBENZENE)	BRL	0.15	1	10,000	MCL	N
	2/9/2010	SW8260B	WG	57	O-XYLENE (1,2-DIMETHYLBENZENE)	BRL	0.33	1	10,000	MCL	N
	4/25/2011	SW8260B	WG	57	O-XYLENE (1,2-DIMETHYLBENZENE)	1.4	0.2	1	10,000	MCL	N
24MW404A	1/9/2009	SW8260B	WG	59	1,2,4-TRIMETHYLBENZENE	**57.7**	0.26	2	17	RBC	**Y**
	2/8/2010	SW8260B	WG	59	1,2,4-TRIMETHYLBENZENE	**57**	0.27	1	17	RBC	**Y**
	4/22/2011	SW8260B	WG	59	1,2,4-TRIMETHYLBENZENE	**94**	1.1	5	17	RBC	**Y**
	1/9/2009	SW8260B	WG	59	1,3,5-TRIMETHYLBENZENE (MESITYLENE)	15.7	0.24	2	17	RBC	N
	2/8/2010	SW8260B	WG	59	1,3,5-TRIMETHYLBENZENE (MESITYLENE)	17	0.21	1	17	RBC	N
	4/22/2011	SW8260B	WG	59	1,3,5-TRIMETHYLBENZENE (MESITYLENE)	**36**	0.2	1	17	RBC	**Y**
	1/9/2009	BNASIM	WG	59	2-METHYLNAPHTHALENE	9.1	0.5	0.5	10	GW-1	N
	2/8/2010	MADEPEP	WG	59	2-METHYLNAPHTHALENE	**10.2 J**	0.034	0.4	10	GW-1	**Y**
	4/22/2011	MADEPEP	WG	59	2-METHYLNAPHTHALENE	**18**	0.1	0.2	10	GW-1	**Y**
	2/8/2010	MADEPEP	WG	59	ACENAPHTHENE	BRL	0.014	0.4	20	GW-1	N
	2/8/2010	MADEPEP	WG	59	C11-C22 AROMATIC HYDROCARBONS	BRL	37	100	200	GW-1	N
	1/9/2009	MADEPVP	WG	59	C5-C8 ALIPHATIC HYDROCARBONS	98	30	30	300	GW-1	N

Table 4-3
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Location	Date	Test	Matrix	Depth (ft bgs)	Analyte	Result	DL	RL	Standard	Type	Exceedance? Y/N
						All units = µg/L					
24MW404A	2/8/2010	MADEPVP	WG	59	C5-C8 ALIPHATIC HYDROCARBONS	56.2	0.76	50	300	GW-1	N
	4/22/2011	MADEPVP	WG	59	C5-C8 ALIPHATIC HYDROCARBONS	123	50	50	300	GW-1	N
	1/9/2009	MADEPVP	WG	59	C9-C10 AROMATIC HYDROCARBONS	**360**	20	20	200	GW-1	**Y**
	2/8/2010	MADEPVP	WG	59	C9-C10 AROMATIC HYDROCARBONS	**317**	1.2	50	200	GW-1	**Y**
	4/22/2011	MADEPVP	WG	59	C9-C10 AROMATIC HYDROCARBONS	**435**	40	40	200	GW-1	**Y**
	1/9/2009	MADEPVP	WG	59	C9-C12 ALIPHATIC HYDROCARBONS	99	30	30	700	GW-1	N
	2/8/2010	MADEPVP	WG	59	C9-C12 ALIPHATIC HYDROCARBONS	174	1.54	50	700	GW-1	N
	4/22/2011	MADEPVP	WG	59	C9-C12 ALIPHATIC HYDROCARBONS	424	20	20	700	GW-1	N
	1/9/2009	SW8260B	WG	59	ETHYLBENZENE	2.5	0.26	2	700	MCL	N
	2/8/2010	SW8260B	WG	59	ETHYLBENZENE	1.6	0.26	1	700	MCL	N
	4/22/2011	SW8260B	WG	59	ETHYLBENZENE	4.5	0.2	1	700	MCL	N
	2/8/2010	MADEPEP	WG	59	FLUORENE	BRL	0.022	0.4	30	GW-1	N
	4/22/2011	MADEPEP	WG	59	FLUORENE	BRL	0.1	0.2	30	GW-1	N
	1/9/2009	SW8260B	WG	59	M,P-XYLENE (SUM OF ISOMERS)	18.6	0.62	4	10,000	MCL	N
	2/8/2010	SW8260B	WG	59	M,P-XYLENE (SUM OF ISOMERS)	13	0.35	2	10,000	MCL	N
	4/22/2011	SW8260B	WG	59	M,P-XYLENE (SUM OF ISOMERS)	32	0.4	1	10,000	MCL	N
	1/9/2009	BNASIM	WG	59	NAPHTHALENE	3.1	0.5	0.5	140	GW-1	N
	2/8/2010	MADEPEP	WG	59	NAPHTHALENE	1.96 J	0.02	0.4	140	GW-1	N
	4/22/2011	MADEPEP	WG	59	NAPHTHALENE	6.5	0.1	0.2	140	GW-1	N
	1/9/2009	SW8260B	WG	59	O-XYLENE (1,2-DIMETHYLBENZENE)	6.8	0.3	2	10,000	MCL	N
	2/8/2010	SW8260B	WG	59	O-XYLENE (1,2-DIMETHYLBENZENE)	4.9	0.33	1	10,000	MCL	N
	4/22/2011	SW8260B	WG	59	O-XYLENE (1,2-DIMETHYLBENZENE)	10	0.2	1	10,000	MCL	N
24MW406A	1/7/2009	SW8260B	WG	57	1,2,4-TRIMETHYLBENZENE	BRL	0.13	1	17	RBC	N
	2/16/2010	SW8260B	WG	57	1,2,4-TRIMETHYLBENZENE	BRL	0.27	1	17	RBC	N
	2/16/2010	MADEPEP	WG	57	2-METHYLNAPHTHALENE	BRL	0.035	0.412	10	GW-1	N
	1/7/2009	MADEPVP	WG	57	C9-C10 AROMATIC HYDROCARBONS	29	20	20	200	GW-1	N
	2/16/2010	MADEPVP	WG	57	C9-C10 AROMATIC HYDROCARBONS	BRL	1.2	50	200	GW-1	N
	2/16/2010	MADEPVP	WG	57	C9-C12 ALIPHATIC HYDROCARBONS	BRL	1.54	50	700	GW-1	N
24MW408A	1/7/2009	SW8260B	WG	37	1,2,4-TRIMETHYLBENZENE	**32.4**	0.26	2	17	RBC	**Y**
	2/12/2010	SW8260B	WG	37	1,2,4-TRIMETHYLBENZENE	**67**	0.27	1	17	RBC	**Y**
	4/25/2011	SW8260B	WG	37	1,2,4-TRIMETHYLBENZENE	**96**	0.22	1	17	RBC	**Y**
	1/7/2009	SW8260B	WG	37	1,3,5-TRIMETHYLBENZENE (MESITYLENE)	11.6	0.24	2	17	RBC	N
	2/12/2010	SW8260B	WG	37	1,3,5-TRIMETHYLBENZENE (MESITYLENE)	**27**	0.21	1	17	RBC	**Y**
	4/25/2011	SW8260B	WG	37	1,3,5-TRIMETHYLBENZENE (MESITYLENE)	**46**	0.2	1	17	RBC	**Y**
	1/7/2009	BNASIM	WG	37	2-METHYLNAPHTHALENE	1.8	0.51	0.51	10	GW-1	N
	2/12/2010	MADEPEP	WG	37	2-METHYLNAPHTHALENE	4.68 J	0.034	0.4	10	GW-1	N
	4/25/2011	MADEPEP	WG	37	2-METHYLNAPHTHALENE	8.7	0.1	0.2	10	GW-1	N
	1/7/2009	MADEPEP	WG	37	C11-C22 AROMATIC HYDROCARBONS	**320**	150	150	200	GW-1	**Y**
	2/12/2010	MADEPEP	WG	37	C11-C22 AROMATIC HYDROCARBONS	113	37	100	200	GW-1	N
	2/12/2010	MADEPEP	WG	37	C19-C36 ALIPHATIC HYDROCARBONS	BRL	6.84	100	14,000	GW-1	N
	1/7/2009	MADEPVP	WG	37	C5-C8 ALIPHATIC HYDROCARBONS	**330**	30	30	300	GW-1	**Y**
	2/12/2010	MADEPVP	WG	37	C5-C8 ALIPHATIC HYDROCARBONS	**424**	0.76	50	300	GW-1	**Y**
	4/25/2011	MADEPVP	WG	37	C5-C8 ALIPHATIC HYDROCARBONS	**510**	100	100	300	GW-1	**Y**
	1/7/2009	MADEPVP	WG	37	C9-C10 AROMATIC HYDROCARBONS	**380**	20	20	200	GW-1	**Y**
	2/12/2010	MADEPVP	WG	37	C9-C10 AROMATIC HYDROCARBONS	**455**	1.2	50	200	GW-1	**Y**
	4/25/2011	MADEPVP	WG	37	C9-C10 AROMATIC HYDROCARBONS	**514**	40	40	200	GW-1	**Y**
	1/7/2009	MADEPVP	WG	37	C9-C12 ALIPHATIC HYDROCARBONS	170	30	30	700	GW-1	N
	2/12/2010	MADEPVP	WG	37	C9-C12 ALIPHATIC HYDROCARBONS	77.6	1.54	50	700	GW-1	N
	4/25/2011	MADEPVP	WG	37	C9-C12 ALIPHATIC HYDROCARBONS	516	40	40	700	GW-1	N
	2/12/2010	MADEPEP	WG	37	C9-C18 ALIPHATIC HYDROCARBONS	BRL	6.14	100	700	GW-1	N
	1/7/2009	SW8260B	WG	37	ETHYLBENZENE	BRL	0.26	2	700	MCL	N
	2/12/2010	SW8260B	WG	37	ETHYLBENZENE	3.5	0.26	1	700	MCL	N
	4/25/2011	SW8260B	WG	37	ETHYLBENZENE	2.1	0.2	1	700	MCL	N
	2/12/2010	MADEPEP	WG	37	FLUORENE	BRL	0.022	0.4	30	GW-1	N
	4/25/2011	MADEPEP	WG	37	FLUORENE	BRL	0.1	0.2	30	GW-1	N
	1/7/2009	SW8260B	WG	37	M,P-XYLENE (SUM OF ISOMERS)	5.3	0.62	4	10,000	MCL	N
	2/12/2010	SW8260B	WG	37	M,P-XYLENE (SUM OF ISOMERS)	19	0.35	2	10,000	MCL	N
	4/25/2011	SW8260B	WG	37	M,P-XYLENE (SUM OF ISOMERS)	19	0.4	1	10,000	MCL	N
	2/12/2010	MADEPEP	WG	37	NAPHTHALENE	1.28 J	0.02	0.4	140	GW-1	N
	4/25/2011	MADEPEP	WG	37	NAPHTHALENE	1.7	0.1	0.2	140	GW-1	N
	1/7/2009	SW8260B	WG	37	O-XYLENE (1,2-DIMETHYLBENZENE)	3.4	0.3	2	10,000	MCL	N
	2/12/2010	SW8260B	WG	37	O-XYLENE (1,2-DIMETHYLBENZENE)	8.7	0.33	1	10,000	MCL	N
	4/25/2011	SW8260B	WG	37	O-XYLENE (1,2-DIMETHYLBENZENE)	5.2	0.2	1	10,000	MCL	N

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						All units = µg/L					
24MW409A	2/12/2010	SW8260B	WG	47	1,2,4-TRIMETHYLBENZENE	13	0.27	1	17	RBC	N
	1/7/2009	SW8260B	WG	47	1,3,5-TRIMETHYLBENZENE (MESITYLENE)	BRL	0.12	1	17	RBC	N
	2/12/2010	SW8260B	WG	47	1,3,5-TRIMETHYLBENZENE (MESITYLENE)	1.3	0.21	1	17	RBC	N
	2/12/2010	MADEPEP	WG	47	2-METHYLNAPHTHALENE	1.07 J	0.034	0.4	10	GW-1	N
	1/7/2009	MADEPEP	WG	47	C11-C22 AROMATIC HYDROCARBONS	190	150	150	200	GW-1	N
	2/12/2010	MADEPEP	WG	47	C11-C22 AROMATIC HYDROCARBONS	BRL	37	100	200	GW-1	N
	2/12/2010	MADEPEP	WG	47	C19-C36 ALIPHATIC HYDROCARBONS	BRL	6.84	100	14,000	GW-1	N
	2/12/2010	MADEPVP	WG	47	C5-C8 ALIPHATIC HYDROCARBONS	69.5	0.76	50	300	GW-1	N
	1/7/2009	MADEPVP	WG	47	C9-C10 AROMATIC HYDROCARBONS	32	20	20	200	GW-1	N
	2/12/2010	MADEPVP	WG	47	C9-C10 AROMATIC HYDROCARBONS	185	1.2	50	200	GW-1	N
	2/12/2010	MADEPVP	WG	47	C9-C12 ALIPHATIC HYDROCARBONS	BRL	1.54	50	700	GW-1	N
	2/12/2010	MADEPEP	WG	47	C9-C18 ALIPHATIC HYDROCARBONS	BRL	6.14	100	700	GW-1	N
	2/12/2010	SW8260B	WG	47	ETHYLBENZENE	BRL	0.26	1	700	MCL	N
	2/12/2010	MADEPEP	WG	47	FLUORENE	BRL	0.022	0.4	30	GW-1	N
	2/12/2010	SW8260B	WG	47	M,P-XYLENE (SUM OF ISOMERS)	BRL	0.35	2	10,000	MCL	N
	2/12/2010	SW8260B	WG	47	O-XYLENE (1,2-DIMETHYLBENZENE)	1.7	0.33	1	10,000	MCL	N
24MW410A	2/11/2010	MADEPEP	WG	47	ANTHRACENE	BRL	0.014	0.412	30	GW-1	N
	2/11/2010	MADEPEP	WG	47	FLUORANTHENE	BRL	0.064	0.412	90	GW-1	N
	2/11/2010	MADEPEP	WG	47	PHENANTHRENE	BRL	0.027	0.412	40	GW-1	N
	2/11/2010	MADEPEP	WG	47	PYRENE	BRL	0.035	0.412	20	GW-1	N
24MW412A	1/8/2009	SW8260B	WG	47	1,2,4-TRIMETHYLBENZENE	**134**	0.65	5	17	RBC	**Y**
	2/11/2010	SW8260B	WG	47	1,2,4-TRIMETHYLBENZENE	**150**	2.7	10	17	RBC	**Y**
	4/26/2011	SW8260B	WG	47	1,2,4-TRIMETHYLBENZENE	**156**	1.1	5	17	RBC	**Y**
	1/8/2009	SW8260B	WG	47	1,3,5-TRIMETHYLBENZENE (MESITYLENE)	**46.9**	0.6	5	17	RBC	**Y**
	2/11/2010	SW8260B	WG	47	1,3,5-TRIMETHYLBENZENE (MESITYLENE)	**61**	2.1	10	17	RBC	**Y**
	4/26/2011	SW8260B	WG	47	1,3,5-TRIMETHYLBENZENE (MESITYLENE)	**75**	0.2	1	17	RBC	**Y**
	1/8/2009	BNASIM	WG	47	2-METHYLNAPHTHALENE	6	0.5	0.5	10	GW-1	N
	2/11/2010	MADEPEP	WG	47	2-METHYLNAPHTHALENE	5.71	0.035	0.412	10	GW-1	N
	4/26/2011	MADEPEP	WG	47	2-METHYLNAPHTHALENE	9.2	0.1	0.2	10	GW-1	N
	2/11/2010	MADEPEP	WG	47	ACENAPHTHENE	BRL	0.014	0.412	20	GW-1	N
	1/8/2009	MADEPEP	WG	47	C11-C22 AROMATIC HYDROCARBONS	150	150	150	200	GW-1	N
	2/11/2010	MADEPEP	WG	47	C11-C22 AROMATIC HYDROCARBONS	BRL	38.1	103	200	GW-1	N
	1/8/2009	MADEPVP	WG	47	C5-C8 ALIPHATIC HYDROCARBONS	**610**	30	30	300	GW-1	**Y**
	2/11/2010	MADEPVP	WG	47	C5-C8 ALIPHATIC HYDROCARBONS	**400**	0.76	50	300	GW-1	**Y**
	4/26/2011	MADEPVP	WG	47	C5-C8 ALIPHATIC HYDROCARBONS	**1010**	50	50	300	GW-1	**Y**
	1/8/2009	MADEPVP	WG	47	C9-C10 AROMATIC HYDROCARBONS	**710**	20	20	200	GW-1	**Y**
	2/11/2010	MADEPVP	WG	47	C9-C10 AROMATIC HYDROCARBONS	**574**	1.2	50	200	GW-1	**Y**
	4/26/2011	MADEPVP	WG	47	C9-C10 AROMATIC HYDROCARBONS	**842**	100	100	200	GW-1	**Y**
	1/8/2009	MADEPVP	WG	47	C9-C12 ALIPHATIC HYDROCARBONS	260	30	30	700	GW-1	N
	2/11/2010	MADEPVP	WG	47	C9-C12 ALIPHATIC HYDROCARBONS	85.1	1.54	50	700	GW-1	N
	4/26/2011	MADEPVP	WG	47	C9-C12 ALIPHATIC HYDROCARBONS	**1260**	100	100	700	GW-1	**Y**
	4/26/2011	MADEPEP	WG	47	C9-C18 ALIPHATIC HYDROCARBONS	214	100	200	700	GW-1	N
	1/8/2009	SW8260B	WG	47	ETHYLBENZENE	92.9	0.65	5	700	MCL	N
	2/11/2010	SW8260B	WG	47	ETHYLBENZENE	88	2.6	10	700	MCL	N
	4/26/2011	SW8260B	WG	47	ETHYLBENZENE	135	1	5	700	MCL	N
	2/11/2010	MADEPEP	WG	47	FLUORENE	BRL	0.023	0.412	30	GW-1	N
	4/26/2011	MADEPEP	WG	47	FLUORENE	BRL	0.1	0.2	30	GW-1	N
	1/8/2009	SW8260B	WG	47	M,P-XYLENE (SUM OF ISOMERS)	378	1.6	10	10,000	MCL	N
	2/11/2010	SW8260B	WG	47	M,P-XYLENE (SUM OF ISOMERS)	370	3.5	20	10,000	MCL	N
	4/26/2011	SW8260B	WG	47	M,P-XYLENE (SUM OF ISOMERS)	550	2	5	10,000	MCL	N
	1/8/2009	BNASIM	WG	47	NAPHTHALENE	12	0.5	0.5	140	GW-1	N
	2/11/2010	MADEPEP	WG	47	NAPHTHALENE	6.76	0.021	0.412	140	GW-1	N
	4/26/2011	MADEPEP	WG	47	NAPHTHALENE	22	0.1	0.2	140	GW-1	N
	1/8/2009	SW8260B	WG	47	O-XYLENE (1,2-DIMETHYLBENZENE)	9	0.75	5	10,000	MCL	N
	2/11/2010	SW8260B	WG	47	O-XYLENE (1,2-DIMETHYLBENZENE)	11	3.3	10	10,000	MCL	N
	4/26/2011	SW8260B	WG	47	O-XYLENE (1,2-DIMETHYLBENZENE)	16	0.2	1	10,000	MCL	N
24MW413A	1/14/2009	SW8260B	WG	59	1,2,4-TRIMETHYLBENZENE	**58.1**	0.13	1	17	RBC	**Y**
	2/8/2010	SW8260B	WG	59	1,2,4-TRIMETHYLBENZENE	**38**	0.27	1	17	RBC	**Y**
	4/22/2011	SW8260B	WG	59	1,2,4-TRIMETHYLBENZENE	**169**	1.1	5	17	RBC	**Y**
	1/14/2009	SW8260B	WG	59	1,3,5-TRIMETHYLBENZENE (MESITYLENE)	**24.5**	0.12	1	17	RBC	**Y**
	2/8/2010	SW8260B	WG	59	1,3,5-TRIMETHYLBENZENE (MESITYLENE)	**19**	0.21	1	17	RBC	**Y**
	4/22/2011	SW8260B	WG	59	1,3,5-TRIMETHYLBENZENE (MESITYLENE)	**93**	0.2	1	17	RBC	**Y**
	1/14/2009	BNASIM	WG	59	2-METHYLNAPHTHALENE	5.1	0.5	0.5	10	GW-1	N
	2/8/2010	MADEPEP	WG	59	2-METHYLNAPHTHALENE	3.37 J	0.034	0.4	10	GW-1	N
	4/22/2011	MADEPEP	WG	59	2-METHYLNAPHTHALENE	**17**	0.1	0.2	10	GW-1	**Y**
	2/8/2010	MADEPEP	WG	59	ACENAPHTHENE	BRL	0.014	0.4	20	GW-1	N
	4/22/2011	MADEPEP	WG	59	ACENAPHTHENE	0.22	0.1	0.2	20	GW-1	N
	2/8/2010	MADEPEP	WG	59	C11-C22 AROMATIC HYDROCARBONS	BRL	37	100	200	GW-1	N
	4/22/2011	MADEPEP	WG	59	C11-C22 AROMATIC HYDROCARBONS	BRL	75	150	200	GW-1	N
	1/14/2009	MADEPVP	WG	59	C5-C8 ALIPHATIC HYDROCARBONS	220	30	30	300	GW-1	N

Table 4-3
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Location	Date	Test	Matrix	Depth (ft bgs)	Analyte	Result	DL	RL	Standard	Type	Exceedance? Y/N
						All units = µg/L					
24MW413A	2/8/2010	MADEPVP	WG	59	C5-C8 ALIPHATIC HYDROCARBONS	74.2	0.76	50	300	GW-1	N
	4/22/2011	MADEPVP	WG	59	C5-C8 ALIPHATIC HYDROCARBONS	**994**	50	50	300	GW-1	**Y**
	1/14/2009	MADEPVP	WG	59	C9-C10 AROMATIC HYDROCARBONS	**360**	20	20	200	GW-1	**Y**
	2/8/2010	MADEPVP	WG	59	C9-C10 AROMATIC HYDROCARBONS	156	1.2	50	200	GW-1	N
	4/22/2011	MADEPVP	WG	59	C9-C10 AROMATIC HYDROCARBONS	**908**	100	100	200	GW-1	**Y**
	1/14/2009	MADEPVP	WG	59	C9-C12 ALIPHATIC HYDROCARBONS	100	30	30	700	GW-1	N
	2/8/2010	MADEPVP	WG	59	C9-C12 ALIPHATIC HYDROCARBONS	87.1	1.54	50	700	GW-1	N
	4/22/2011	MADEPVP	WG	59	C9-C12 ALIPHATIC HYDROCARBONS	**812**	100	100	700	GW-1	**Y**
	4/22/2011	MADEPEP	WG	59	C9-C18 ALIPHATIC HYDROCARBONS	BRL	100	200	700	GW-1	N
	1/14/2009	SW8260B	WG	59	ETHYLBENZENE	BRL	0.13	1	700	MCL	N
	4/22/2011	SW8260B	WG	59	ETHYLBENZENE	BRL	0.2	1	700	MCL	N
	2/8/2010	MADEPEP	WG	59	FLUORENE	BRL	0.022	0.4	30	GW-1	N
	4/22/2011	MADEPEP	WG	59	FLUORENE	0.3	0.1	0.2	30	GW-1	N
	1/14/2009	SW8260B	WG	59	M,P-XYLENE (SUM OF ISOMERS)	2.5	0.31	2	10,000	MCL	N
	2/8/2010	SW8260B	WG	59	M,P-XYLENE (SUM OF ISOMERS)	BRL	0.35	2	10,000	MCL	N
	4/22/2011	SW8260B	WG	59	M,P-XYLENE (SUM OF ISOMERS)	1.8	0.4	1	10,000	MCL	N
24MW414A	1/8/2009	SW8260B	WG	57	1,2,4-TRIMETHYLBENZENE	2.2	0.13	1	17	RBC	N
	2/16/2010	MADEPEP	WG	57	ACENAPHTHENE	BRL	0.014	0.408	20	GW-1	N
	2/16/2010	MADEPEP	WG	57	ACENAPHTHYLENE	BRL	0.025	0.408	30	GW-1	N
	2/16/2010	MADEPEP	WG	57	ANTHRACENE	BRL	0.014	0.408	30	GW-1	N
	2/16/2010	MADEPEP	WG	57	BENZO(a)ANTHRACENE	BRL	0.041	0.408	1	GW-1	N
	2/16/2010	MADEPEP	WG	57	BENZO(a)PYRENE	**0.226**	0.065	0.2	0.2	GW-1	**Y**
	2/16/2010	MADEPEP	WG	57	BENZO(b)FLUORANTHENE	BRL	0.043	0.408	1	GW-1	N
	2/16/2010	MADEPEP	WG	57	BENZO(g,h,i)PERYLENE	BRL	0.049	0.408	20	GW-1	N
	2/16/2010	MADEPEP	WG	57	C11-C22 AROMATIC HYDROCARBONS	116	37.8	102	200	GW-1	N
	1/8/2009	MADEPVP	WG	57	C5-C8 ALIPHATIC HYDROCARBONS	100	30	30	300	GW-1	N
	2/16/2010	MADEPVP	WG	57	C5-C8 ALIPHATIC HYDROCARBONS	268	0.76	50	300	GW-1	N
	1/8/2009	MADEPVP	WG	57	C9-C10 AROMATIC HYDROCARBONS	110	20	20	200	GW-1	N
	2/16/2010	MADEPVP	WG	57	C9-C10 AROMATIC HYDROCARBONS	BRL	1.2	50	200	GW-1	N
	1/8/2009	MADEPVP	WG	57	C9-C12 ALIPHATIC HYDROCARBONS	56	30	30	700	GW-1	N
	2/16/2010	MADEPVP	WG	57	C9-C12 ALIPHATIC HYDROCARBONS	52.7	1.54	50	700	GW-1	N
	2/16/2010	MADEPEP	WG	57	CHRYSENE	BRL	0.047	0.408	2	GW-1	N
	1/8/2009	SW8260B	WG	57	ETHYLBENZENE	BRL	0.13	1	700	MCL	N
	2/16/2010	MADEPEP	WG	57	FLUORANTHENE	BRL	0.063	0.408	90	GW-1	N
	2/16/2010	MADEPEP	WG	57	FLUORENE	BRL	0.022	0.408	30	GW-1	N
	2/16/2010	MADEPEP	WG	57	INDENO(1,2,3-c,d)PYRENE	BRL	0.053	0.408	0.5	GW-1	N
	1/8/2009	BNASIM	WG	57	NAPHTHALENE	0.58	0.5	0.5	140	GW-1	N
	2/16/2010	MADEPEP	WG	57	PHENANTHRENE	BRL	0.027	0.408	40	GW-1	N
	2/16/2010	MADEPEP	WG	57	PYRENE	BRL	0.035	0.408	20	GW-1	N
24MW415A	2/16/2010	MADEPEP	WG	49	2-METHYLNAPHTHALENE	BRL	0.035	0.408	10	GW-1	N
	2/16/2010	MADEPVP	WG	49	C5-C8 ALIPHATIC HYDROCARBONS	BRL	0.76	50	300	GW-1	N
	2/16/2010	MADEPVP	WG	49	C9-C10 AROMATIC HYDROCARBONS	BRL	1.2	50	200	GW-1	N
	2/16/2010	MADEPVP	WG	49	C9-C12 ALIPHATIC HYDROCARBONS	BRL	1.54	50	700	GW-1	N
	2/16/2010	MADEPEP	WG	49	FLUORENE	BRL	0.022	0.408	30	GW-1	N
24MW416A	2/12/2010	SW8260B	WG	37	1,2,4-TRIMETHYLBENZENE	8.9	0.27	1	17	RBC	N
	2/12/2010	SW8260B	WG	37	1,3,5-TRIMETHYLBENZENE (MESITYLENE)	4.2	0.21	1	17	RBC	N
	2/12/2010	MADEPEP	WG	37	C11-C22 AROMATIC HYDROCARBONS	BRL	37	100	200	GW-1	N
	2/12/2010	MADEPEP	WG	37	C19-C36 ALIPHATIC HYDROCARBONS	BRL	6.84	100	14,000	GW-1	N
	2/12/2010	MADEPVP	WG	37	C5-C8 ALIPHATIC HYDROCARBONS	149	0.76	50	300	GW-1	N
	1/8/2009	MADEPVP	WG	37	C9-C10 AROMATIC HYDROCARBONS	30	20	20	200	GW-1	N
	2/12/2010	MADEPVP	WG	37	C9-C10 AROMATIC HYDROCARBONS	98.9	1.2	50	200	GW-1	N
	2/12/2010	MADEPVP	WG	37	C9-C12 ALIPHATIC HYDROCARBONS	BRL	1.54	50	700	GW-1	N
	2/12/2010	MADEPEP	WG	37	C9-C18 ALIPHATIC HYDROCARBONS	BRL	6.14	100	700	GW-1	N
	2/12/2010	SW8260B	WG	37	ETHYLBENZENE	1.1	0.26	1	700	MCL	N
	2/12/2010	MADEPEP	WG	37	FLUORENE	BRL	0.022	0.4	30	GW-1	N
	2/12/2010	SW8260B	WG	37	M,P-XYLENE (SUM OF ISOMERS)	BRL	0.35	2	10,000	MCL	N
	2/12/2010	SW8260B	WG	37	O-XYLENE (1,2-DIMETHYLBENZENE)	BRL	0.33	1	10,000	MCL	N
24MW417A	1/9/2009	SW8260B	WG	59	1,2,4-TRIMETHYLBENZENE	**97.9**	0.65	5	17	RBC	**Y**
	2/8/2010	SW8260B	WG	59	1,2,4-TRIMETHYLBENZENE	**150**	1.1	4	17	RBC	**Y**
	4/22/2011	SW8260B	WG	59	1,2,4-TRIMETHYLBENZENE	**88**	1.1	5	17	RBC	**Y**
	1/9/2009	SW8260B	WG	59	1,3,5-TRIMETHYLBENZENE (MESITYLENE)	**39.8**	0.6	5	17	RBC	**Y**
	2/8/2010	SW8260B	WG	59	1,3,5-TRIMETHYLBENZENE (MESITYLENE)	**66**	0.84	4	17	RBC	**Y**
	4/22/2011	SW8260B	WG	59	1,3,5-TRIMETHYLBENZENE (MESITYLENE)	**60**	0.2	1	17	RBC	**Y**
	1/9/2009	BNASIM	WG	59	2-METHYLNAPHTHALENE	2.4	0.5	0.5	10	GW-1	N
	2/8/2010	MADEPEP	WG	59	2-METHYLNAPHTHALENE	6.72 J	0.034	0.4	10	GW-1	N
	4/22/2011	MADEPEP	WG	59	2-METHYLNAPHTHALENE	5.5	0.1	0.2	10	GW-1	N
	2/8/2010	MADEPEP	WG	59	ACENAPHTHENE	BRL	0.014	0.4	20	GW-1	N
	2/8/2010	MADEPEP	WG	59	C11-C22 AROMATIC HYDROCARBONS	BRL	37	100	200	GW-1	N
	1/9/2009	MADEPVP	WG	59	C5-C8 ALIPHATIC HYDROCARBONS	**390**	30	30	300	GW-1	**Y**
	2/8/2010	MADEPVP	WG	59	C5-C8 ALIPHATIC HYDROCARBONS	**498**	3.8	250	300	GW-1	**Y**

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Location	Date	Test	Matrix	Depth (ft bgs)	Analyte	Result	DL	RL	Standard	Type	Exceedance? Y/N
						All units = µg/L					
24MW417A	4/22/2011	MADEPVP	WG	59	C5-C8 ALIPHATIC HYDROCARBONS	**435**	50	50	300	GW-1	**Y**
	1/9/2009	MADEPVP	WG	59	C9-C10 AROMATIC HYDROCARBONS	**520**	20	20	200	GW-1	**Y**
	2/8/2010	MADEPVP	WG	59	C9-C10 AROMATIC HYDROCARBONS	**584**	6	250	200	GW-1	**Y**
	4/22/2011	MADEPVP	WG	59	C9-C10 AROMATIC HYDROCARBONS	**516**	40	40	200	GW-1	**Y**
	1/9/2009	MADEPVP	WG	59	C9-C12 ALIPHATIC HYDROCARBONS	130	30	30	700	GW-1	N
	2/8/2010	MADEPVP	WG	59	C9-C12 ALIPHATIC HYDROCARBONS	349	7.7	250	700	GW-1	N
	4/22/2011	MADEPVP	WG	59	C9-C12 ALIPHATIC HYDROCARBONS	509	40	40	700	GW-1	N
	1/9/2009	SW8260B	WG	59	ETHYLBENZENE	11.1	0.65	5	700	MCL	N
	2/8/2010	SW8260B	WG	59	ETHYLBENZENE	15	1.1	4	700	MCL	N
	4/22/2011	SW8260B	WG	59	ETHYLBENZENE	14	0.2	1	700	MCL	N
	2/8/2010	MADEPEP	WG	59	FLUORENE	BRL	0.022	0.4	30	GW-1	N
	1/9/2009	SW8260B	WG	59	M,P-XYLENE (SUM OF ISOMERS)	77	1.6	10	10,000	MCL	N
	2/8/2010	SW8260B	WG	59	M,P-XYLENE (SUM OF ISOMERS)	110	1.4	8	10,000	MCL	N
	4/22/2011	SW8260B	WG	59	M,P-XYLENE (SUM OF ISOMERS)	94	0.4	1	10,000	MCL	N
	1/9/2009	BNASIM	WG	59	NAPHTHALENE	0.77	0.5	0.5	140	GW-1	N
	2/8/2010	MADEPEP	WG	59	NAPHTHALENE	1.73 J	0.02	0.4	140	GW-1	N
	4/22/2011	MADEPEP	WG	59	NAPHTHALENE	1.6	0.1	0.2	140	GW-1	N
	1/9/2009	SW8260B	WG	59	O-XYLENE (1,2-DIMETHYLBENZENE)	15.6	0.75	5	10,000	MCL	N
	2/8/2010	SW8260B	WG	59	O-XYLENE (1,2-DIMETHYLBENZENE)	18	1.3	4	10,000	MCL	N
	4/22/2011	SW8260B	WG	59	O-XYLENE (1,2-DIMETHYLBENZENE)	20	0.2	1	10,000	MCL	N
	2/8/2010	MADEPEP	WG	59	PHENANTHRENE	BRL	0.026	0.4	40	GW-1	N
24MW418A	4/25/2011	SW8260B	WG	40	1,2,4-TRIMETHYLBENZENE	BRL	0.22	1	17	RBC	N
	1/8/2009	SW8260B	WG	40	1,3,5-TRIMETHYLBENZENE (MESITYLENE)	BRL	0.12	1	17	RBC	N
	4/25/2011	MADEPEP	WG	40	2-METHYLNAPHTHALENE	BRL	0.1	0.2	10	GW-1	N
	2/12/2010	MADEPEP	WG	40	C11-C22 AROMATIC HYDROCARBONS	BRL	37	100	200	GW-1	N
	2/12/2010	MADEPEP	WG	40	C19-C36 ALIPHATIC HYDROCARBONS	BRL	6.84	100	14,000	GW-1	N
	1/8/2009	MADEPVP	WG	40	C5-C8 ALIPHATIC HYDROCARBONS	36	30	30	300	GW-1	N
	2/12/2010	MADEPVP	WG	40	C5-C8 ALIPHATIC HYDROCARBONS	86.6	0.76	50	300	GW-1	N
	4/25/2011	MADEPVP	WG	40	C5-C8 ALIPHATIC HYDROCARBONS	186	50	50	300	GW-1	N
	1/8/2009	MADEPVP	WG	40	C9-C10 AROMATIC HYDROCARBONS	26	20	20	200	GW-1	N
	2/12/2010	MADEPVP	WG	40	C9-C10 AROMATIC HYDROCARBONS	65.7	1.2	50	200	GW-1	N
	4/25/2011	MADEPVP	WG	40	C9-C10 AROMATIC HYDROCARBONS	99	20	20	200	GW-1	N
	2/12/2010	MADEPVP	WG	40	C9-C12 ALIPHATIC HYDROCARBONS	BRL	1.54	50	700	GW-1	N
	4/25/2011	MADEPVP	WG	40	C9-C12 ALIPHATIC HYDROCARBONS	144	20	20	700	GW-1	N
	2/12/2010	MADEPEP	WG	40	FLUORENE	BRL	0.022	0.4	30	GW-1	N
24MW421A	1/9/2009	SW8260B	WG	57	1,2,4-TRIMETHYLBENZENE	1.1	0.13	1	17	RBC	N
	1/9/2009	MADEPVP	WG	57	C5-C8 ALIPHATIC HYDROCARBONS	51	30	30	300	GW-1	N
	1/9/2009	MADEPVP	WG	57	C9-C10 AROMATIC HYDROCARBONS	110	20	20	200	GW-1	N
	2/5/2010	MADEPVP	WG	57	C9-C10 AROMATIC HYDROCARBONS	BRL	1.2	50	200	GW-1	N
	1/9/2009	MADEPVP	WG	57	C9-C12 ALIPHATIC HYDROCARBONS	54	30	30	700	GW-1	N
24MW422A	1/14/2009	SW8260B	WG	55	1,2,4-TRIMETHYLBENZENE	**22.5**	0.13	1	17	RBC	**Y**
	2/9/2010	SW8260B	WG	55	1,2,4-TRIMETHYLBENZENE	16	0.27	1	17	RBC	N
	4/25/2011	SW8260B	WG	55	1,2,4-TRIMETHYLBENZENE	12	0.22	1	17	RBC	N
	1/14/2009	SW8260B	WG	55	1,3,5-TRIMETHYLBENZENE (MESITYLENE)	6.7	0.12	1	17	RBC	N
	2/9/2010	SW8260B	WG	55	1,3,5-TRIMETHYLBENZENE (MESITYLENE)	5.3	0.21	1	17	RBC	N
	1/14/2009	BNASIM	WG	55	2-METHYLNAPHTHALENE	8.3	0.5	0.5	10	GW-1	N
	2/9/2010	MADEPEP	WG	55	2-METHYLNAPHTHALENE	**10.5**	0.034	0.4	10	GW-1	**Y**
	4/25/2011	MADEPEP	WG	55	2-METHYLNAPHTHALENE	9.3	0.1	0.2	10	GW-1	N
	1/14/2009	MADEPVP	WG	55	C5-C8 ALIPHATIC HYDROCARBONS	98	30	30	300	GW-1	N
	2/9/2010	MADEPVP	WG	55	C5-C8 ALIPHATIC HYDROCARBONS	55	0.76	50	300	GW-1	N
	1/14/2009	MADEPVP	WG	55	C9-C10 AROMATIC HYDROCARBONS	**330**	20	20	200	GW-1	**Y**
	2/9/2010	MADEPVP	WG	55	C9-C10 AROMATIC HYDROCARBONS	186	1.2	50	200	GW-1	N
	4/25/2011	MADEPVP	WG	55	C9-C10 AROMATIC HYDROCARBONS	195	20	20	200	GW-1	N
	1/14/2009	MADEPVP	WG	55	C9-C12 ALIPHATIC HYDROCARBONS	100	30	30	700	GW-1	N
	2/9/2010	MADEPVP	WG	55	C9-C12 ALIPHATIC HYDROCARBONS	117	1.54	50	700	GW-1	N

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						All units = µg/L					
24MW422A	4/25/2011	MADEPVP	WG	55	C9-C12 ALIPHATIC HYDROCARBONS	188	20	20	700	GW-1	N
	2/9/2010	MADEPEP	WG	55	FLUORENE	BRL	0.022	0.4	30	GW-1	N
	4/25/2011	MADEPEP	WG	55	FLUORENE	BRL	0.1	0.2	30	GW-1	N
	1/14/2009	BNASIM	WG	55	NAPHTHALENE	0.63	0.5	0.5	140	GW-1	N
	4/25/2011	MADEPEP	WG	55	NAPHTHALENE	1	0.1	0.2	140	GW-1	N

Data Source: AFCEC, June 2013, AFCEC-MMR Data Warehouse.

Notes:

1. MCLs from U.S. Environmental Protection Agency (EPA) web page, http://www.epa.gov/safewater/contaminants/index.html.
2. GW-1 = MassDEP MCP Method 1 Groundwater-1 Standards from MassDEP web page http://www.mass.gov/dep/cleanup/laws/0974_2.htm.
3. No federal or site-specific cleanup standard for either of the isomers of trimethylbenzene (TMB) have been developed. However, a risk-based concentration of 17 µg/L was established for the Fuel Spill-13 groundwater site (Final Record of Decision for the CS-4, CS-20, CS-21 and FS-13 Plumes, dated February 2000).
4. Value presented is the MCL for total xylenes. MCLs for individual isomers of xylene is not available.
5. This tables presents the detected compounds from three sampling events conducted at select PFSA monitoring wells between 2009 and 2011. All samples were analyzed for VOC (including TMBs) and EPH/VPH by MassDEP Method.

Bold values represent concentrations above the groundwater standard (i.e., MCL, RBC, or GW-1).

Key:
BRL = below reporting limit
CS = Chemical Spill
DL = detection limit
EPH = extractable petroleum hydrocarbons
FS = Fuel Spill
GW-1 = Groundwater-1
J = estimated value
MassDEP = Massachusetts Department of Environmental Protection
MCL = Maximum Contaminant Level
MCP = Massachusetts Contingency Plan
ND = not detected
PFSA = Petroleum Fuel Storage Area
RBC = risk based concentration
RL = reporting limit
TMB = trimethylbenzene
VPH = volatile petroleum hydrocarbons
VOC = volatile organic compound
WG = groundwater
µg/L = micrograms per liter

Table 4-4
SD-4 Sediment Sampling Results - July 2012
Final 4th Five-Year Review, 2007-2012

Location	Date	Test	Depth (ft bgs)	Analyte	Result	DL	RL	Units	Qualifier	2013 ESD RALs	MCP S-1/GW-1	EPA RSL (Residential)	Most Stringent Screening Level	Exceedance? Y/N
LKSD4-4	7/16/2012	SW6020A	0-0.25	ARSENIC	**0.48**	0.016	0.5	mg/kg	J	NA	20	0.39	0.39	**Y**
LKSD4-4	7/16/2012	SW6010B	0-0.25	CADMIUM	0.5	0.16	1	mg/kg	J	NA	2	70	2	N
LKSD4-4	7/16/2012	SW6020A	0-0.25	CHROMIUM, TOTAL	**3**	0.014	0.2	mg/kg		19	30	0.29[1]	0.29	**Y**
LKSD4-4	7/16/2012	SW6010B	0-0.25	LEAD	25	1.4	5	mg/kg	J	99	300	400	99	N
LKSD4-4	7/16/2012	SW6010B	0-0.25	NICKEL	1.4	0.4	1	mg/kg		NA	20	1,500	20	N
LKSD4-4	7/16/2012	SW6010B	0-0.25	VANADIUM	3	0.26	1	mg/kg		47	600	390	47	N
LKSD4-5	7/16/2012	SW6020A	0-0.25	ARSENIC	**3.1**	0.016	0.5	mg/kg		NA	20	0.39	0.39	**Y**
LKSD4-5	7/16/2012	SW6010B	0-0.25	CADMIUM	**13**	0.16	1	mg/kg		NA	2	70	2	**Y**
LKSD4-5	7/16/2012	SW6020A	0-0.25	CHROMIUM, TOTAL	**88**	0.35	5	mg/kg		19	30	0.29[1]	0.29	**Y**
LKSD4-5	7/16/2012	SW6010B	0-0.25	LEAD	**570**	1.4	5	mg/kg		99	300	400	99	**Y**
LKSD4-5	7/16/2012	SW6010B	0-0.25	NICKEL	**26**	0.4	1	mg/kg		NA	20	1,500	20	**Y**
LKSD4-5	7/16/2012	SW6010B	0-0.25	VANADIUM	**50**	0.26	1	mg/kg		47	600	390	47	**Y**
LKSD4-6	7/16/2012	SW6020A	0-0.25	ARSENIC	**7**	0.016	0.5	mg/kg		NA	20	0.39	0.39	**Y**
LKSD4-6	7/16/2012	SW6010B	0-0.25	CADMIUM	**16**	0.15	0.93	mg/kg		NA	2	70	2	**Y**
LKSD4-6	7/16/2012	SW6020A	0-0.25	CHROMIUM, TOTAL	**90**	0.35	5	mg/kg		19	30	0.29[1]	0.29	**Y**
LKSD4-6	7/16/2012	SW6010B	0-0.25	LEAD	**590**	13	47	mg/kg		99	300	400	99	**Y**
LKSD4-6	7/16/2012	SW6010B	0-0.25	NICKEL	**40**	0.37	0.93	mg/kg		NA	20	1,500	20	**Y**
LKSD4-6	7/16/2012	SW6010B	0-0.25	VANADIUM	**58**	0.24	0.93	mg/kg		47	600	390	47	**Y**

Data Source: AFCEE, September 2012, MMR-AFCEE Data Warehouse

Notes:

EPA Regional Screening Levels (Residential) from RSL summary table at: http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/Generic_Tables/pdf/master_sl_table_run_MAY2012.pdf

MCP method 1 S-1/GW-1 standards from: http://www.mass.gov/dep/cleanup/laws/0975_6a.htm.

[1] = total chromium does not have an EPA RSL (Residential) value; the RSL presented is for hexavalent chromium.

Bold values represent concentrations above the noted screening levels (i.e., 2013 ESD RAL, MCP S-1/GW-1, or EPA RSL).

Key:

DL = detection limit
EPA = U.S. Environmental Protection Agency
ESD = Explanation of Significant Differences
ft bgs = feet below ground surface
GW-1 = Groundwater-1
J = estimated value
MCP = Massachusetts Contingency Plan
NA = not available
mg/kg = milligrams per kilogram
RAL = remedial action level
RL = reporting limit
RSL = regional screening level
S-1 = Soil-1
SD-4 = Storm Drain-4

APPENDIX A

Newspaper Announcement

PUBLIC NOTICE

2013 Five Year Review has begun for the Installation Restoration Program (IRP) at the Massachusetts Military Reservation (MMR)

The Air Force Civil Engineer Center (AFCEC) announces the start of a required Five Year Review of its environmental cleanup program at the MMR. AFCEC manages the IRP which is charged with investigating and cleaning up hazardous waste conditions at the base.

The majority of contaminants that the program deals with are TCE, PCE and EDB. The program currently has 9 groundwater treatment plants addressing 10 plumes of groundwater contamination emanating from the base. Two other plumes and two sites are being monitored.

There are 80 source areas in the program. 77 of those have been investigated and/or had cleanup completed. 3 source areas are being monitored.

The 2013 Five Year Review will document all of the cleanup actions and evaluate their status in terms of effectiveness and the protection of public health. Updates on the Five Year Review will be given at future meetings of the MMR Cleanup Team which is an advisory committee to the Air Force and Army. Team meetings are open to the public.

The review is expected to be completed in September 2013. A copy of the final Review will be placed in the main Upper Cape Libraries.

For more information,
please contact
Doug Karson
508-968-4678 ext. 2

APPENDIX B

Source Area Site Inspection Reports

CS-10 Site Inspection

Five-Year Review Site Inspection Checklist

I. SITE INFORMATION	
Site name: Chemical Spill-10 Source Area	**Date of inspection: 6/19/13**
Location and Region: Eastern boundary of MMR	**EPA ID:** MA2570024487
Agency, office, or company leading the five-year review: AFCEC	**Weather/temperature: sunny, clear, 70s**

Remedy Includes: (Check all that apply)

- ☐ Landfill cover/containment
- ☐ Access controls
- ☐ Institutional controls
- ☐ Groundwater pump and treatment
- ☐ Surface water collection and treatment
- ☐ Other - **Not Applicable**
- ☐ Monitored natural attenuation
- ☐ Groundwater containment
- ☐ Vertical barrier walls

____

Attachments: ☐ Inspection team roster attached ☐ Site map attached **See Figure 4-1**

II. INTERVIEWS Not conducted since no ongoing O&M (See Section 3.6)

1. **O&M site manager** _ _________________ _______________________ _____________
Name Title Date
Interviewed ☐ at site ☐ at office ☐ by phone Phone no. _______________
Problems, suggestions; ☐ Report attached ☐ ____
____

2. **O&M staff** ___ _________________ _____________
Name Title Date
Interviewed ☐ at site ☐ at office ☐ by phone Phone no. _______________
Problems, suggestions; ☐ Report attached ____
____

3.	**Local regulatory authorities and response agencies** (i.e., State and Tribal offices, emergency response office, police department, office of public health or environmental health, zoning office, recorder of deeds, or other city and county offices, etc.) Fill in all that apply. Agency ______________________________ Contact ______________________________ ___________________ ________ ____________ Name Title Date Phone no. Problems; suggestions; ☐ Report attached ____ Agency ______________________________ Contact ______________________________ ___________________ ________ ____________ Name Title Date Phone no. Problems; suggestions; ☐ Report attached ____ Agency ______________________________ Contact ______________________________ ___________________ ________ ____________ Name Title Date Phone no. Problems; suggestions; ☐ Report attached ____ Agency ______________________________ Contact ______________________________ ___________________ ________ ____________ Name Title Date Phone no. Problems; suggestions; ☐ Report attached ____
4.	**Other interviews** (optional) ☐ Report attached.
none	

III. ON-SITE DOCUMENTS & RECORDS VERIFIED (Check all that apply)				
1.	**O&M Documents**			
	☐ O&M manual	☐ Readily available	☐ Up to date	x N/A
	☐ As-built drawings	☐ Readily available	☐ Up to date	x N/A
	☐ Maintenance logs	☐ Readily available	☐ Up to date	x N/A
	Remarks______________________________________			
2.	**Site-Specific Health and Safety Plan**	x Readily available	x Up to date	☐ N/A
	☐ Contingency plan/emergency response plan	x Readily available	x Up to date	☐ N/A
	Remarks______________________________________			
3.	**O&M and OSHA Training Records**	☐ Readily available	☐ Up to date	x N/A
	Remarks______________________________________			
4.	**Permits and Service Agreements**			
	☐ Air discharge permit	☐ Readily available	☐ Up to date	x N/A
	☐ Effluent discharge	☐ Readily available	☐ Up to date	x N/A
	☐ Waste disposal, POTW	☐ Readily available	☐ Up to date	x N/A
	☐ Other permits_____________________	☐ Readily available	☐ Up to date	x N/A
	Remarks______________________________________			
5.	**Gas Generation Records**	☐ Readily available	☐ Up to date	x N/A
	Remarks______________________________________			
6.	**Settlement Monument Records**	☐ Readily available	☐ Up to date	x N/A
	Remarks______________________________________			
7.	**Groundwater Monitoring Records**	☐ Readily available	☐ Up to date	x N/A
	Remarks______________________________________			
8.	**Leachate Extraction Records**	☐ Readily available	☐ Up to date	x N/A
	Remarks______________________________________			
9.	**Discharge Compliance Records**			
	☐ Air	☐ Readily available	☐ Up to date	x N/A
	☐ Water (effluent)	☐ Readily available	☐ Up to date	x N/A
	Remarks______________________________________			
10.	**Daily Access/Security Logs**	☐ Readily available	☐ Up to date	x N/A
	Remarks______________________________________			

IV. O&M COSTS Not Applicable

1. **O&M Organization**
   - ☐ State in-house ☐ Contractor for State
   - ☐ PRP in-house ☐ Contractor for PRP
   - ☐ Federal Facility in-house ☐ Contractor for Federal Facility
   - ☐ Other____

2. **O&M Cost Records**
   - ☐ Readily available ☐ Up to date
   - ☐ Funding mechanism/agreement in place

   Original O&M cost estimate____________________ ☐ Breakdown attached

   Total annual cost by year for review period if available

From__________ Date	To__________ Date	__________ Total cost	☐ Breakdown attached
From__________ Date	To__________ Date	__________ Total cost	☐ Breakdown attached
From__________ Date	To__________ Date	__________ Total cost	☐ Breakdown attached
From__________ Date	To__________ Date	__________ Total cost	☐ Breakdown attached
From__________ Date	To__________ Date	__________ Total cost	☐ Breakdown attached

3. **Unanticipated or Unusually High O&M Costs During Review Period**
   Describe costs and reasons: ____

V. ACCESS AND INSTITUTIONAL CONTROLS ☐ Applicable x N/A

A. Fencing

1. **Fencing damaged** ☐ Location shown on site map ☐ Gates secured ☐ N/A
   Remarks____

B. Other Access Restrictions

1. **Signs and other security measures** ☐ Location shown on site map ☐ N/A
   Remarks____

C. Institutional Controls (ICs)	
1.	**Implementation and enforcement** Site conditions imply ICs not properly implemented ☐ Yes ☐ No ☐ N/A Site conditions imply ICs not being fully enforced ☐ Yes ☐ No ☐ N/A Type of monitoring (*e.g.*, self-reporting, drive by) ________________ Frequency ________________ Responsible party/agency ________________ Contact ________________ ________________ ________ ________ Name Title Date Phone no. Reporting is up-to-date ☐ Yes ☐ No ☐ N/A Reports are verified by the lead agency ☐ Yes ☐ No ☐ N/A Specific requirements in deed or decision documents have been met ☐ Yes ☐ No ☐ N/A Violations have been reported ☐ Yes ☐ No ☐ N/A Other problems or suggestions: ☐ Report attached ________________ ________________ ________________ ________________
2.	**Adequacy** ☐ ICs are adequate ☐ ICs are inadequate ☐ N/A Remarks________________ ________________ ________________
D. General	
1.	**Vandalism/trespassing** ☐ Location shown on site map ☐ No vandalism evident Remarks________________ ________________
2.	**Land use changes on site** ☐ N/A Remarks________________ ________________
3.	**Land use changes off site** ☐ N/A Remarks________________ ________________
VI. GENERAL SITE CONDITIONS	
A. Roads x Applicable ☐ N/A	
1.	**Roads damaged** ☐ Location shown on site map x Roads adequate ☐ N/A Remarks________________ ________________

B. Other Site Conditions	
	Remarks ____

VII. LANDFILL COVERS ☐ Applicable x N/A

A. Landfill Surface	
1.	**Settlement** (Low spots) ☐ Location shown on site map ☐ Settlement not evident Areal extent______________ Depth____________ Remarks____
2.	**Cracks** ☐ Location shown on site map ☐ Cracking not evident Lengths____________ Widths___________ Depths__________ Remarks____
3.	**Erosion** ☐ Location shown on site map ☐ Erosion not evident Areal extent______________ Depth____________ Remarks____
4.	**Holes** ☐ Location shown on site map ☐ Holes not evident Areal extent______________ Depth____________ Remarks____
5.	**Vegetative Cover** ☐ Grass ☐ Cover properly established ☐ No signs of stress ☐ Trees/Shrubs (indicate size and locations on a diagram) Remarks____
6.	**Alternative Cover (armored rock, concrete, etc.)** ☐ N/A Remarks____
7.	**Bulges** ☐ Location shown on site map ☐ Bulges not evident Areal extent______________ Height____________ Remarks____

8.	**Wet Areas/Water Damage** ☐ Wet areas/water damage not evident ☐ Wet areas ☐ Location shown on site map Areal extent______________ ☐ Ponding ☐ Location shown on site map Areal extent______________ ☐ Seeps ☐ Location shown on site map Areal extent______________ ☐ Soft subgrade ☐ Location shown on site map Areal extent______________ Remarks____	
9.	**Slope Instability** ☐ Slides ☐ Location shown on site map ☐ No evidence of slope instability Areal extent______________ Remarks____	
B. Benches	☐ Applicable ☐ N/A (Horizontally constructed mounds of earth placed across a steep landfill side slope to interrupt the slope in order to slow down the velocity of surface runoff and intercept and convey the runoff to a lined channel.)	
1.	**Flows Bypass Bench** ☐ Location shown on site map ☐ N/A or okay Remarks____	
2.	**Bench Breached** ☐ Location shown on site map ☐ N/A or okay Remarks____	
3.	**Bench Overtopped** ☐ Location shown on site map ☐ N/A or okay Remarks____	
C. Letdown Channels	☐ Applicable ☐ N/A (Channel lined with erosion control mats, riprap, grout bags, or gabions that descend down the steep side slope of the cover and will allow the runoff water collected by the benches to move off of the landfill cover without creating erosion gullies.)	
1.	**Settlement** ☐ Location shown on site map ☐ No evidence of settlement Areal extent______________ Depth____________ Remarks____	
2.	**Material Degradation** ☐ Location shown on site map ☐ No evidence of degradation Material type_______________ Areal extent_____________ Remarks____	
3.	**Erosion** ☐ Location shown on site map ☐ No evidence of erosion Areal extent______________ Depth____________ Remarks____	

4.	**Undercutting** ☐ Location shown on site map ☐ No evidence of undercutting Areal extent______________ Depth____________ Remarks____ ____	
5.	**Obstructions** Type_____________________ ☐ No obstructions ☐ Location shown on site map Areal extent______________ Size____________ Remarks____ ____	
6.	**Excessive Vegetative Growth** Type____________________ ☐ No evidence of excessive growth ☐ Vegetation in channels does not obstruct flow ☐ Location shown on site map Areal extent______________ Remarks____ ____	
D. Cover Penetrations ☐ Applicable ☐ N/A		
1.	**Gas Vents** ☐ Active ☐ Passive ☐ Properly secured/locked ☐ Functioning ☐ Routinely sampled ☐ Good condition ☐ Evidence of leakage at penetration ☐ Needs Maintenance ☐ N/A Remarks____ ____	
2.	**Gas Monitoring Probes** ☐ Properly secured/locked ☐ Functioning ☐ Routinely sampled ☐ Good condition ☐ Evidence of leakage at penetration ☐ Needs Maintenance ☐ N/A Remarks____ ____	
3.	**Monitoring Wells** (within surface area of landfill) ☐ Properly secured/locked ☐ Functioning ☐ Routinely sampled ☐ Good condition ☐ Evidence of leakage at penetration ☐ Needs Maintenance ☐ N/A Remarks____ ____	
4.	**Leachate Extraction Wells** ☐ Properly secured/locked ☐ Functioning ☐ Routinely sampled ☐ Good condition ☐ Evidence of leakage at penetration ☐ Needs Maintenance ☐ N/A Remarks____ ____	
5.	**Settlement Monuments** ☐ Located ☐ Routinely surveyed ☐ N/A Remarks____ ____	

E. Gas Collection and Treatment ☐ Applicable ☐ N/A
1. **Gas Treatment Facilities** ☐ Flaring ☐ Thermal destruction ☐ Collection for reuse ☐ Good condition ☐ Needs Maintenance Remarks____
2. **Gas Collection Wells, Manifolds and Piping** ☐ Good condition ☐ Needs Maintenance Remarks____
3. **Gas Monitoring Facilities** (*e.g.*, gas monitoring of adjacent homes or buildings) ☐ Good condition ☐ Needs Maintenance ☐ N/A Remarks____
F. Cover Drainage Layer ☐ Applicable ☐ N/A
1. **Outlet Pipes Inspected** ☐ Functioning ☐ N/A Remarks____
2. **Outlet Rock Inspected** ☐ Functioning ☐ N/A Remarks____
G. Detention/Sedimentation Ponds ☐ Applicable ☐ N/A
1. **Siltation** Areal extent______________ Depth____________ ☐ N/A ☐ Siltation not evident Remarks____
2. **Erosion** Areal extent______________ Depth____________ ☐ Erosion not evident Remarks____
3. **Outlet Works** ☐ Functioning ☐ N/A Remarks____
4. **Dam** ☐ Functioning ☐ N/A Remarks____

H. Retaining Walls	□ Applicable □ N/A		
1.	**Deformations**	□ Location shown on site map	□ Deformation not evident
	Horizontal displacement____________ Vertical displacement_______________ Rotational displacement____________ Remarks____		
2.	**Degradation**	□ Location shown on site map	□ Degradation not evident
	Remarks____		
I. Perimeter Ditches/Off-Site Discharge	□ Applicable □ N/A		
1.	**Siltation**	□ Location shown on site map	□ Siltation not evident
	Areal extent______________ Depth____________ Remarks____		
2.	**Vegetative Growth**	□ Location shown on site map	□ N/A
	□ Vegetation does not impede flow Areal extent______________ Type____________ Remarks____		
3.	**Erosion**	□ Location shown on site map	□ Erosion not evident
	Areal extent______________ Depth____________ Remarks____		
4.	**Discharge Structure**	□ Functioning □ N/A	
	Remarks____		
VIII. VERTICAL BARRIER WALLS	□ Applicable x N/A		
1.	**Settlement**	□ Location shown on site map	□ Settlement not evident
	Areal extent______________ Depth____________ Remarks____		
2.	**Performance Monitoring** Type of monitoring_________________________		
	□ Performance not monitored Frequency________________________________ □ Evidence of breaching Head differential__________________________ Remarks____		

IX. GROUNDWATER/SURFACE WATER REMEDIES ☐ Applicable x N/A
A. Groundwater Extraction Wells, Pumps, and Pipelines ☐ Applicable ☐ N/A
1. **Pumps, Wellhead Plumbing, and Electrical** ☐ Good condition ☐ All required wells properly operating ☐ Needs Maintenance ☐ N/A Remarks____
2. **Extraction System Pipelines, Valves, Valve Boxes, and Other Appurtenances** ☐ Good condition ☐ Needs Maintenance Remarks____
3. **Spare Parts and Equipment** ☐ Readily available ☐ Good condition ☐ Requires upgrade ☐ Needs to be provided Remarks____
B. Surface Water Collection Structures, Pumps, and Pipelines ☐ Applicable ☐ N/A
1. **Collection Structures, Pumps, and Electrical** ☐ Good condition ☐ Needs Maintenance Remarks____
2. **Surface Water Collection System Pipelines, Valves, Valve Boxes, and Other Appurtenances** ☐ Good condition ☐ Needs Maintenance Remarks____
3. **Spare Parts and Equipment** ☐ Readily available ☐ Good condition ☐ Requires upgrade ☐ Needs to be provided Remarks____

C. Treatment System	☐ Applicable ☐ N/A	
1.	**Treatment Train** (Check components that apply) ☐ Metals removal ☐ Oil/water separation ☐ Bioremediation ☐ Air stripping ☐ Carbon adsorbers ☐ Filters____________________ ☐ Additive (*e.g.*, chelation agent, flocculent)____________________ ☐ Others____________________ ☐ Good condition ☐ Needs Maintenance ☐ Sampling ports properly marked and functional ☐ Sampling/maintenance log displayed and up to date ☐ Equipment properly identified ☐ Quantity of groundwater treated annually____________________ ☐ Quantity of surface water treated annually____________________ Remarks____________________	
2.	**Electrical Enclosures and Panels** (properly rated and functional) ☐ N/A ☐ Good condition ☐ Needs Maintenance Remarks____________________	
3.	**Tanks, Vaults, Storage Vessels** ☐ N/A ☐ Good condition ☐ Proper secondary containment ☐ Needs Maintenance Remarks____________________	
4.	**Discharge Structure and Appurtenances** ☐ N/A ☐ Good condition ☐ Needs Maintenance Remarks____________________	
5.	**Treatment Building(s)** ☐ N/A ☐ Good condition (esp. roof and doorways) ☐ Needs repair ☐ Chemicals and equipment properly stored Remarks____________________	
6.	**Monitoring Wells** (pump and treatment remedy) ☐ Properly secured/locked ☐ Functioning ☐ Routinely sampled ☐ Good condition ☐ All required wells located ☐ Needs Maintenance ☐ N/A Remarks____________________	
D. Monitoring Data		
1.	Monitoring Data ☐ Is routinely submitted on time ☐ Is of acceptable quality	
2.	Monitoring data suggests: ☐ Groundwater plume is effectively contained ☐ Contaminant concentrations are declining	

D. Monitored Natural Attenuation

1. **Monitoring Wells** (natural attenuation remedy)
☐ Properly secured/locked ☐ Functioning ☐ Routinely sampled ☐ Good condition
☐ All required wells located ☐ Needs Maintenance ☐ N/A
Remarks____
____

X. OTHER REMEDIES

If there are remedies applied at the site which are not covered above, attach an inspection sheet describing the physical nature and condition of any facility associated with the remedy. An example would be soil vapor extraction.

XI. OVERALL OBSERVATIONS

A. Implementation of the Remedy

Describe issues and observations relating to whether the remedy is effective and functioning as designed. Begin with a brief statement of what the remedy is to accomplish (i.e., to contain contaminant plume, minimize infiltration and gas emission, etc.).
Former SVE system for CS-10 Detail C now removed, no active treatment for CS-10 Detail F

B. Adequacy of O&M

Describe issues and observations related to the implementation and scope of O&M procedures. In particular, discuss their relationship to the current and long-term protectiveness of the remedy.
Not Applicable

C. Early Indicators of Potential Remedy Problems

Describe issues and observations such as unexpected changes in the cost or scope of O&M or a high frequency of unscheduled repairs, that suggest that the protectiveness of the remedy may be compromised in the future.
None

D. Opportunities for Optimization

Describe possible opportunities for optimization in monitoring tasks or the operation of the remedy.
None

CS-10 Photo 1: CS-10 Detail C

CS-10 Photo 2: CS-10 Detail C

CS-10 Photo 3: CS-10 Detail F
(wetland located in depression behind guardrail)

FTA-2/LF-2 Site Inspection

Five-Year Review Site Inspection Checklist

<table>
<tr><td colspan="2">I. SITE INFORMATION</td></tr>
<tr><td>Site name: Fire Training Area-2/Landfill-2</td><td>Date of inspection: 7/10/13</td></tr>
<tr><td>Location and Region: Approximately 250 feet west of the southern end of Runway No. 5, within the flightline security area.</td><td>EPA ID: MA2570024487</td></tr>
<tr><td>Agency, office, or company leading the five-year review: AFCEC</td><td>Weather/temperature: 80’s, overcast, light wind</td></tr>
<tr><td colspan="2">Remedy Includes: (Check all that apply)
☐ Landfill cover/containment
☐ Access controls
x Institutional controls
☐ Groundwater pump and treatment
☐ Surface water collection and treatment
☐ Other_______________________________________
☐ Monitored natural attenuation
☐ Groundwater containment
☐ Vertical barrier walls</td></tr>
<tr><td colspan="2">Attachments: ☐ Inspection team roster attached ☐ Site map attached See Figure 4-4</td></tr>
<tr><td colspan="2">II. INTERVIEWS (Check all that apply) Not conducted since no ongoing O&M (See Section 3.6)</td></tr>
<tr><td colspan="2">1. O&M site manager ______________________ ______________________ __________
Name Title Date
Interviewed ☐ at site ☐ at office ☐ by phone Phone no. __________
Problems, suggestions; ☐ Report attached ☐ ______________________________________
____</td></tr>
<tr><td colspan="2">2. O&M staff ______________________ ______________________ __________
Name Title Date
Interviewed ☐ at site ☐ at office ☐ by phone Phone no. __________
Problems, suggestions; ☐ Report attached ______________________________________
____</td></tr>
</table>

3.	**Local regulatory authorities and response agencies** (i.e., State and Tribal offices, emergency response office, police department, office of public health or environmental health, zoning office, recorder of deeds, or other city and county offices, etc.) Fill in all that apply. Agency ______________________________ Contact ______________________________ ___________________ ________ ____________ Name Title Date Phone no. Problems; suggestions; ☐ Report attached ____ ____ Agency ______________________________ Contact ______________________________ ___________________ ________ ____________ Name Title Date Phone no. Problems; suggestions; ☐ Report attached ____ ____ Agency ______________________________ Contact ______________________________ ___________________ ________ ____________ Name Title Date Phone no. Problems; suggestions; ☐ Report attached ____ ____ Agency ______________________________ Contact ______________________________ ___________________ ________ ____________ Name Title Date Phone no. Problems; suggestions; ☐ Report attached ____ ____
4.	**Other interviews** (optional) ☐ Report attached.
None	

III. ON-SITE DOCUMENTS & RECORDS VERIFIED (Check all that apply)				
1.	**O&M Documents**			
	☐ O&M manual	☐ Readily available	☐ Up to date	x N/A
	☐ As-built drawings	☐ Readily available	☐ Up to date	x N/A
	☐ Maintenance logs	☐ Readily available	☐ Up to date	x N/A
	Remarks______________________________			
2.	**Site-Specific Health and Safety Plan**	x Readily available	x Up to date	☐ N/A
	☐ Contingency plan/emergency response plan	x Readily available	x Up to date	☐ N/A
	Remarks______________________________			
3.	**O&M and OSHA Training Records**	☐ Readily available	☐ Up to date	x N/A
	Remarks______________________________			
4.	**Permits and Service Agreements**			
	☐ Air discharge permit	☐ Readily available	☐ Up to date	x N/A
	☐ Effluent discharge	☐ Readily available	☐ Up to date	x N/A
	☐ Waste disposal, POTW	☐ Readily available	☐ Up to date	x N/A
	☐ Other permits_____________________	☐ Readily available	☐ Up to date	x N/A
	Remarks______________________________			
5.	**Gas Generation Records**	☐ Readily available	☐ Up to date	x N/A
	Remarks______________________________			
6.	**Settlement Monument Records**	☐ Readily available	☐ Up to date	x N/A
	Remarks______________________________			
7.	**Groundwater Monitoring Records**	☐ Readily available	☐ Up to date	x N/A
	Remarks______________________________			
8.	**Leachate Extraction Records**	☐ Readily available	☐ Up to date	x N/A
	Remarks______________________________			
9.	**Discharge Compliance Records**			
	☐ Air	☐ Readily available	☐ Up to date	x N/A
	☐ Water (effluent)	☐ Readily available	☐ Up to date	x N/A
	Remarks______________________________			
10.	**Daily Access/Security Logs**	☐ Readily available	☐ Up to date	x N/A
	Remarks______________________________			

IV. O&M COSTS **Not Applicable**
1. **O&M Organization** ☐ State in-house ☐ Contractor for State ☐ PRP in-house ☐ Contractor for PRP ☐ Federal Facility in-house ☐ Contractor for Federal Facility ☐ Other____ ____
2. **O&M Cost Records** ☐ Readily available ☐ Up to date ☐ Funding mechanism/agreement in place Original O&M cost estimate________________ ☐ Breakdown attached Total annual cost by year for review period if available From________ To________ ____________ ☐ Breakdown attached Date Date Total cost From________ To________ ____________ ☐ Breakdown attached Date Date Total cost From________ To________ ____________ ☐ Breakdown attached Date Date Total cost From________ To________ ____________ ☐ Breakdown attached Date Date Total cost From________ To________ ____________ ☐ Breakdown attached Date Date Total cost
3. **Unanticipated or Unusually High O&M Costs During Review Period** Describe costs and reasons: ______________________________ ____ ____ ____ ____ ____
V. ACCESS AND INSTITUTIONAL CONTROLS ☐ Applicable x N/A
A. Fencing
1. **Fencing damaged** ☐ Location shown on site map ☐ Gates secured ☐ N/A Remarks____ ____
B. Other Access Restrictions
1. **Signs and other security measures** ☐ Location shown on site map ☐ N/A Remarks____ ____

C. Institutional Controls (ICs)
1. **Implementation and enforcement** Site conditions imply ICs not properly implemented ☐ Yes ☐ No ☐ N/A Site conditions imply ICs not being fully enforced ☐ Yes ☐ No ☐ N/A Type of monitoring (*e.g.*, self-reporting, drive by) ____________ Frequency ____________ Responsible party/agency ____________ Contact ____________ ____________ ________ ________ Name Title Date Phone no. Reporting is up-to-date ☐ Yes ☐ No ☐ N/A Reports are verified by the lead agency ☐ Yes ☐ No ☐ N/A Specific requirements in deed or decision documents have been met ☐ Yes ☐ No ☐ N/A Violations have been reported ☐ Yes ☐ No ☐ N/A Other problems or suggestions: ☐ Report attached
2. **Adequacy** ☐ ICs are adequate ☐ ICs are inadequate ☐ N/A Remarks____________
D. General
1. **Vandalism/trespassing** ☐ Location shown on site map ☐ No vandalism evident Remarks____________
2. **Land use changes on site** ☐ N/A Remarks____________
3. **Land use changes off site** ☐ N/A Remarks____________
VI. GENERAL SITE CONDITIONS
A. Roads ☐ Applicable ☐ N/A
1. **Roads damaged** ☐ Location shown on site map ☐ Roads adequate x N/A Remarks____________

B. Other Site Conditions

Remarks ____

____

____

____

____

____

VII. LANDFILL COVERS ☐ Applicable x N/A

A. Landfill Surface

1. **Settlement** (Low spots) ☐ Location shown on site map ☐ Settlement not evident
   Areal extent______________ Depth____________
   Remarks____
   ____

2. **Cracks** ☐ Location shown on site map ☐ Cracking not evident
   Lengths____________ Widths___________ Depths__________
   Remarks____
   ____

3. **Erosion** ☐ Location shown on site map ☐ Erosion not evident
   Areal extent______________ Depth____________
   Remarks____
   ____

4. **Holes** ☐ Location shown on site map ☐ Holes not evident
   Areal extent______________ Depth____________
   Remarks____
   ____

5. **Vegetative Cover** ☐ Grass ☐ Cover properly established ☐ No signs of stress
   ☐ Trees/Shrubs (indicate size and locations on a diagram)
   Remarks____
   ____

6. **Alternative Cover (armored rock, concrete, etc.)** ☐ N/A
   Remarks____
   ____

7. **Bulges** ☐ Location shown on site map ☐ Bulges not evident
   Areal extent______________ Height____________
   Remarks____
   ____

8.	**Wet Areas/Water Damage** ☐ Wet areas/water damage not evident ☐ Wet areas ☐ Location shown on site map Areal extent______________ ☐ Ponding ☐ Location shown on site map Areal extent______________ ☐ Seeps ☐ Location shown on site map Areal extent______________ ☐ Soft subgrade ☐ Location shown on site map Areal extent______________ Remarks____ ____
9.	**Slope Instability** ☐ Slides ☐ Location shown on site map ☐ No evidence of slope instability Areal extent______________ Remarks____ ____
B. Benches	☐ Applicable ☐ N/A (Horizontally constructed mounds of earth placed across a steep landfill side slope to interrupt the slope in order to slow down the velocity of surface runoff and intercept and convey the runoff to a lined channel.)
1.	**Flows Bypass Bench** ☐ Location shown on site map ☐ N/A or okay Remarks____ ____
2.	**Bench Breached** ☐ Location shown on site map ☐ N/A or okay Remarks____ ____
3.	**Bench Overtopped** ☐ Location shown on site map ☐ N/A or okay Remarks____ ____
C. Letdown Channels	☐ Applicable ☐ N/A (Channel lined with erosion control mats, riprap, grout bags, or gabions that descend down the steep side slope of the cover and will allow the runoff water collected by the benches to move off of the landfill cover without creating erosion gullies.)
1.	**Settlement** ☐ Location shown on site map ☐ No evidence of settlement Areal extent______________ Depth____________ Remarks____ ____
2.	**Material Degradation** ☐ Location shown on site map ☐ No evidence of degradation Material type_______________ Areal extent_____________ Remarks____ ____
3.	**Erosion** ☐ Location shown on site map ☐ No evidence of erosion Areal extent______________ Depth____________ Remarks____ ____

4.	**Undercutting** ☐ Location shown on site map ☐ No evidence of undercutting Areal extent______________ Depth____________ Remarks____ ____	
5.	**Obstructions** Type_____________________ ☐ No obstructions ☐ Location shown on site map Areal extent______________ Size____________ Remarks____ ____	
6.	**Excessive Vegetative Growth** Type____________________ ☐ No evidence of excessive growth ☐ Vegetation in channels does not obstruct flow ☐ Location shown on site map Areal extent______________ Remarks____ ____	
D. Cover Penetrations ☐ Applicable ☐ N/A		
1.	**Gas Vents** ☐ Active ☐ Passive ☐ Properly secured/locked ☐ Functioning ☐ Routinely sampled ☐ Good condition ☐ Evidence of leakage at penetration ☐ Needs Maintenance ☐ N/A Remarks____ ____	
2.	**Gas Monitoring Probes** ☐ Properly secured/locked ☐ Functioning ☐ Routinely sampled ☐ Good condition ☐ Evidence of leakage at penetration ☐ Needs Maintenance ☐ N/A Remarks____ ____	
3.	**Monitoring Wells** (within surface area of landfill) ☐ Properly secured/locked ☐ Functioning ☐ Routinely sampled ☐ Good condition ☐ Evidence of leakage at penetration ☐ Needs Maintenance ☐ N/A Remarks____ ____	
4.	**Leachate Extraction Wells** ☐ Properly secured/locked ☐ Functioning ☐ Routinely sampled ☐ Good condition ☐ Evidence of leakage at penetration ☐ Needs Maintenance ☐ N/A Remarks____ ____	
5.	**Settlement Monuments** ☐ Located ☐ Routinely surveyed ☐ N/A Remarks____ ____	

E. Gas Collection and Treatment	☐ Applicable ☐ N/A	
1.	**Gas Treatment Facilities** ☐ Flaring ☐ Thermal destruction ☐ Collection for reuse ☐ Good condition ☐ Needs Maintenance Remarks____ ____	
2.	**Gas Collection Wells, Manifolds and Piping** ☐ Good condition ☐ Needs Maintenance Remarks____ ____	
3.	**Gas Monitoring Facilities** (*e.g.*, gas monitoring of adjacent homes or buildings) ☐ Good condition ☐ Needs Maintenance ☐ N/A Remarks____ ____	
F. Cover Drainage Layer	☐ Applicable ☐ N/A	
1.	**Outlet Pipes Inspected** ☐ Functioning ☐ N/A Remarks____ ____	
2.	**Outlet Rock Inspected** ☐ Functioning ☐ N/A Remarks____ ____	
G. Detention/Sedimentation Ponds	☐ Applicable ☐ N/A	
1.	**Siltation** Areal extent______________ Depth____________ ☐ N/A ☐ Siltation not evident Remarks____ ____	
2.	**Erosion** Areal extent______________ Depth____________ ☐ Erosion not evident Remarks____ ____	
3.	**Outlet Works** ☐ Functioning ☐ N/A Remarks____ ____	
4.	**Dam** ☐ Functioning ☐ N/A Remarks____ ____	

H. Retaining Walls □ Applicable □ N/A	
1.	**Deformations** □ Location shown on site map □ Deformation not evident Horizontal displacement_____________ Vertical displacement_______________ Rotational displacement_____________ Remarks____ ____
2.	**Degradation** □ Location shown on site map □ Degradation not evident Remarks____ ____
I. Perimeter Ditches/Off-Site Discharge □ Applicable □ N/A	
1.	**Siltation** □ Location shown on site map □ Siltation not evident Areal extent______________ Depth____________ Remarks____ ____
2.	**Vegetative Growth** □ Location shown on site map □ N/A □ Vegetation does not impede flow Areal extent______________ Type____________ Remarks____ ____
3.	**Erosion** □ Location shown on site map □ Erosion not evident Areal extent______________ Depth____________ Remarks____ ____
4.	**Discharge Structure** □ Functioning □ N/A Remarks____ ____
VIII. VERTICAL BARRIER WALLS □ Applicable x N/A	
1.	**Settlement** □ Location shown on site map □ Settlement not evident Areal extent______________ Depth____________ Remarks____ ____
2.	**Performance Monitoring** Type of monitoring__________________________ □ Performance not monitored Frequency________________________________ □ Evidence of breaching Head differential__________________________ Remarks____ ____

IX. GROUNDWATER/SURFACE WATER REMEDIES ☐ Applicable x N/A
A. Groundwater Extraction Wells, Pumps, and Pipelines ☐ Applicable ☐ N/A
1. **Pumps, Wellhead Plumbing, and Electrical** ☐ Good condition ☐ All required wells properly operating ☐ Needs Maintenance ☐ N/A Remarks_______________
2. **Extraction System Pipelines, Valves, Valve Boxes, and Other Appurtenances** ☐ Good condition ☐ Needs Maintenance Remarks_______________
3. **Spare Parts and Equipment** ☐ Readily available ☐ Good condition ☐ Requires upgrade ☐ Needs to be provided Remarks_______________
B. Surface Water Collection Structures, Pumps, and Pipelines ☐ Applicable ☐ N/A
1. **Collection Structures, Pumps, and Electrical** ☐ Good condition ☐ Needs Maintenance Remarks_______________
2. **Surface Water Collection System Pipelines, Valves, Valve Boxes, and Other Appurtenances** ☐ Good condition ☐ Needs Maintenance Remarks_______________
3. **Spare Parts and Equipment** ☐ Readily available ☐ Good condition ☐ Requires upgrade ☐ Needs to be provided Remarks_______________

C. Treatment System	☐ Applicable ☐ N/A
1.	**Treatment Train** (Check components that apply) ☐ Metals removal ☐ Oil/water separation ☐ Bioremediation ☐ Air stripping ☐ Carbon adsorbers ☐ Filters________________________________ ☐ Additive (*e.g.*, chelation agent, flocculent)________________________________ ☐ Others________________________________ ☐ Good condition ☐ Needs Maintenance ☐ Sampling ports properly marked and functional ☐ Sampling/maintenance log displayed and up to date ☐ Equipment properly identified ☐ Quantity of groundwater treated annually________________________ ☐ Quantity of surface water treated annually________________________ Remarks________________________________ ________________________________
2.	**Electrical Enclosures and Panels** (properly rated and functional) ☐ N/A ☐ Good condition ☐ Needs Maintenance Remarks________________________________ ________________________________
3.	**Tanks, Vaults, Storage Vessels** ☐ N/A ☐ Good condition ☐ Proper secondary containment ☐ Needs Maintenance Remarks________________________________ ________________________________
4.	**Discharge Structure and Appurtenances** ☐ N/A ☐ Good condition ☐ Needs Maintenance Remarks________________________________ ________________________________
5.	**Treatment Building(s)** ☐ N/A ☐ Good condition (esp. roof and doorways) ☐ Needs repair ☐ Chemicals and equipment properly stored Remarks________________________________ ________________________________
6.	**Monitoring Wells** (pump and treatment remedy) ☐ Properly secured/locked ☐ Functioning ☐ Routinely sampled ☐ Good condition ☐ All required wells located ☐ Needs Maintenance ☐ N/A Remarks________________________________ ________________________________
D. Monitoring Data	
1.	Monitoring Data ☐ Is routinely submitted on time ☐ Is of acceptable quality
2.	Monitoring data suggests: ☐ Groundwater plume is effectively contained ☐ Contaminant concentrations are declining

D. Monitored Natural Attenuation
1. **Monitoring Wells** (natural attenuation remedy) □ Properly secured/locked □ Functioning □ Routinely sampled □ Good condition □ All required wells located □ Needs Maintenance □ N/A Remarks____ ____
X. OTHER REMEDIES
If there are remedies applied at the site which are not covered above, attach an inspection sheet describing the physical nature and condition of any facility associated with the remedy. An example would be soil vapor extraction. **Not Applicable**
XI. OVERALL OBSERVATIONS
A. Implementation of the Remedy
Describe issues and observations relating to whether the remedy is effective and functioning as designed. Begin with a brief statement of what the remedy is to accomplish (i.e., to contain contaminant plume, minimize infiltration and gas emission, etc.). **Former SVE system to remediate petroleum contamination in soil (now shutdown).**
B. Adequacy of O&M
Describe issues and observations related to the implementation and scope of O&M procedures. In particular, discuss their relationship to the current and long-term protectiveness of the remedy. **Not Applicable**
C. Early Indicators of Potential Remedy Problems
Describe issues and observations such as unexpected changes in the cost or scope of O&M or a high frequency of unscheduled repairs, that suggest that the protectiveness of the remedy may be compromised in the future. **Not Applicable**
D. Opportunities for Optimization
Describe possible opportunities for optimization in monitoring tasks or the operation of the remedy. **Not Applicable**

FTA-2/LF-2 Photo 1

LF-1 Site Inspection

Five-Year Review Site Inspection Checklist

I. SITE INFORMATION	
Site name: Landfill-1 Source Area	**Date of inspection: 6/19/13**
Location and Region: Southern portion of MMR and is bounded by Turpentine Road to the east, Frank Perkins Road to the west, Herbert Road to the north, and Connery Avenue to the south	**EPA ID:** MA2570024487
Agency, office, or company leading the five-year review: AFCEC	**Weather/temperature: Sunny, clear, 70's**

Remedy Includes: (Check all that apply)

x Landfill cover/containment ☐ Monitored natural attenuation
☐ Access controls ☐ Groundwater containment
x Institutional controls ☐ Vertical barrier walls
☐ Groundwater pump and treatment
☐ Surface water collection and treatment
x Other: **Fence and Annual Inspections**

____

Attachments: ☐ Inspection team roster attached ☐ Site map attached **See Figure 4-3**

II. INTERVIEWS Not conducted since no ongoing O&M (See Section 3.6)

1. **O&M site manager** ____________________________ ______________________ ____________
Name Title Date
Interviewed ☐ at site ☐ at office ☐ by phone Phone no. ______________
Problems, suggestions; ☐ Report attached ☐ ____
____

2. **O&M staff** ____________________________ ______________________ ____________
Name Title Date
Interviewed ☐ at site ☐ at office ☐ by phone Phone no. ______________
Problems, suggestions; ☐ Report attached ____
____

3.	**Local regulatory authorities and response agencies** (i.e., State and Tribal offices, emergency response office, police department, office of public health or environmental health, zoning office, recorder of deeds, or other city and county offices, etc.) Fill in all that apply. Agency __________________________ Contact __________________________ ________________ _______ __________ Name Title Date Phone no. Problems; suggestions; ☐ Report attached ________________________________ Agency __________________________ Contact __________________________ ________________ _______ __________ Name Title Date Phone no. Problems; suggestions; ☐ Report attached ________________________________ Agency __________________________ Contact __________________________ ________________ _______ __________ Name Title Date Phone no. Problems; suggestions; ☐ Report attached ________________________________ Agency __________________________ Contact __________________________ ________________ _______ __________ Name Title Date Phone no. Problems; suggestions; ☐ Report attached ________________________________
4.	**Other interviews** (optional) ☐ Report attached.
None	

III. ON-SITE DOCUMENTS & RECORDS VERIFIED (Check all that apply)				
1.	**O&M Documents**			
	☐ O&M manual	☐ Readily available	☐ Up to date	x N/A
	☐ As-built drawings	☐ Readily available	☐ Up to date	x N/A
	☐ Maintenance logs	☐ Readily available	☐ Up to date	x N/A
	Remarks___			
2.	**Site-Specific Health and Safety Plan**	x Readily available	x Up to date	☐ N/A
	☐ Contingency plan/emergency response plan	x Readily available	x Up to date	☐ N/A
	Remarks___			
3.	**O&M and OSHA Training Records**	☐ Readily available	☐ Up to date	x N/A
	Remarks___			
4.	**Permits and Service Agreements**			
	☐ Air discharge permit	☐ Readily available	☐ Up to date	x N/A
	☐ Effluent discharge	☐ Readily available	☐ Up to date	x N/A
	☐ Waste disposal, POTW	☐ Readily available	☐ Up to date	x N/A
	☐ Other permits___	☐ Readily available	☐ Up to date	x N/A
	Remarks___			
5.	**Gas Generation Records**	x Readily available	☐ Up to date	x N/A
	Remarks___			
6.	**Settlement Monument Records**	x Readily available	☐ Up to date	x N/A
	Remarks___			
7.	**Groundwater Monitoring Records**	x Readily available	☐ Up to date	x N/A
	Remarks___			
8.	**Leachate Extraction Records**	☐ Readily available	☐ Up to date	x N/A
	Remarks___			
9.	**Discharge Compliance Records**			
	☐ Air	☐ Readily available	☐ Up to date	x N/A
	☐ Water (effluent)	☐ Readily available	☐ Up to date	x N/A
	Remarks___			
10.	**Daily Access/Security Logs**	☐ Readily available	☐ Up to date	x N/A
	Remarks___			

IV. O&M COSTS: Not Applicable

1. **O&M Organization**
☐ State in-house ☐ Contractor for State
☐ PRP in-house ☐ Contractor for PRP
☐ Federal Facility in-house ☐ Contractor for Federal Facility
☐ Other____

2. **O&M Cost Records**
☐ Readily available ☐ Up to date
☐ Funding mechanism/agreement in place
Original O&M cost estimate____________________ ☐ Breakdown attached

Total annual cost by year for review period if available

From__________ To__________ ____________________ ☐ Breakdown attached
Date Date Total cost
From__________ To__________ ____________________ ☐ Breakdown attached
Date Date Total cost
From__________ To__________ ____________________ ☐ Breakdown attached
Date Date Total cost
From__________ To__________ ____________________ ☐ Breakdown attached
Date Date Total cost
From__________ To__________ ____________________ ☐ Breakdown attached
Date Date Total cost

3. **Unanticipated or Unusually High O&M Costs During Review Period**
Describe costs and reasons: ____

V. ACCESS AND INSTITUTIONAL CONTROLS x Applicable ☐ N/A

A. Fencing

1. **Fencing damaged** ☐ Location shown on site map x Gates secured ☐ N/A
Remarks: **Fence in good condition (see photo #1)**

B. Other Access Restrictions

1. **Signs and other security measures** ☐ Location shown on site map ☐ N/A
Remarks: **Signs in place (see photo #2)**

C. Institutional Controls (ICs)	
1.	**Implementation and enforcement** Site conditions imply ICs not properly implemented ☐ Yes x No ☐ N/A Site conditions imply ICs not being fully enforced ☐ Yes x No ☐ N/A Type of monitoring (*e.g.*, self-reporting, drive by): **PCM activities included Landfill Cap Inspections, Settlement Surveys, Topographic Surveys, Gas Vent Monitoring** Frequency: **Semiannual Gas Vent Monitoring, Annual Landfill Cap Inspections and Settlement Surveys, Topo surveys every 5 years.** Responsible party/agency **AFCEC** Contact **Jon Davis** (Name) **AFCEC PM** (Title) **6/19/13** (Date) **(508) 968-4670 (ext 4952)** (Phone no.) Reporting is up-to-date x Yes ☐ No ☐ N/A Reports are verified by the lead agency x Yes ☐ No ☐ N/A Specific requirements in deed or decision documents have been met x Yes ☐ No ☐ N/A Violations have been reported ☐ Yes x No ☐ N/A Other problems or suggestions: ☐ Report attached **Landfill Monitoring Results are provided to the regulatory agencies annually in LF-1/CS-23 Summary Letter Reports**
2.	**Adequacy** x ICs are adequate ☐ ICs are inadequate ☐ N/A Remarks
D. General	
1.	**Vandalism/trespassing** ☐ Location shown on site map x No vandalism evident Remarks
2.	**Land use changes on site** ☐ N/A Remarks: **None**
3.	**Land use changes off site** x N/A Remarks
VI. GENERAL SITE CONDITIONS	
A. Roads x Applicable ☐ N/A	
1.	**Roads damaged** ☐ Location shown on site map x Roads adequate ☐ N/A Remarks

B. Other Site Conditions
Remarks None
VII. LANDFILL COVERS x Applicable ☐ N/A
A. Landfill Surface LF-1 landfill cap photos attached (photo's #2-5)
1. **Settlement** (Low spots) ☐ Location shown on site map x Settlement not evident Areal extent______ Depth______ Remarks______
2. **Cracks** ☐ Location shown on site map x Cracking not evident Lengths______ Widths______ Depths______ Remarks______
3. **Erosion** ☐ Location shown on site map ☐ Erosion not evident Areal extent______ Depth______ Remarks **Minor erosion rills were repaired with hand tools during this 5-year review period**
4. **Holes** ☐ Location shown on site map x Holes not evident Areal extent______ Depth______ Remarks______
5. **Vegetative Cover** x Grass ☐ Cover properly established ☐ No signs of stress ☐ Trees/Shrubs (indicate size and locations on a diagram) Remarks: **Grass is mowed annually as required by PCM plan**
6. **Alternative Cover (armored rock, concrete, etc.)** x N/A Remarks______
7. **Bulges** ☐ Location shown on site map x Bulges not evident Areal extent______ Height______ Remarks______

8.	**Wet Areas/Water Damage** x Wet areas/water damage not evident ☐ Wet areas ☐ Location shown on site map Areal extent______________ ☐ Ponding ☐ Location shown on site map Areal extent______________ ☐ Seeps ☐ Location shown on site map Areal extent______________ ☐ Soft subgrade ☐ Location shown on site map Areal extent______________ Remarks____
9.	**Slope Instability** ☐ Slides ☐ Location shown on site map x No evidence of slope instability Areal extent______________ Remarks____
B. Benches ☐ Applicable x N/A	(Horizontally constructed mounds of earth placed across a steep landfill side slope to interrupt the slope in order to slow down the velocity of surface runoff and intercept and convey the runoff to a lined channel.)
1.	**Flows Bypass Bench** ☐ Location shown on site map ☐ N/A or okay Remarks____
2.	**Bench Breached** ☐ Location shown on site map ☐ N/A or okay Remarks____
3.	**Bench Overtopped** ☐ Location shown on site map ☐ N/A or okay Remarks____
C. Letdown Channels ☐ Applicable x N/A	(Channel lined with erosion control mats, riprap, grout bags, or gabions that descend down the steep side slope of the cover and will allow the runoff water collected by the benches to move off of the landfill cover without creating erosion gullies.)
1.	**Settlement** ☐ Location shown on site map ☐ No evidence of settlement Areal extent______________ Depth____________ Remarks____
2.	**Material Degradation** ☐ Location shown on site map ☐ No evidence of degradation Material type_______________ Areal extent_____________ Remarks____
3.	**Erosion** ☐ Location shown on site map ☐ No evidence of erosion Areal extent______________ Depth____________ Remarks____

4.	**Undercutting** ☐ Location shown on site map ☐ No evidence of undercutting Areal extent______________ Depth____________ Remarks____
5.	**Obstructions** Type_____________________ ☐ No obstructions ☐ Location shown on site map Areal extent______________ Size____________ Remarks____
6.	**Excessive Vegetative Growth** Type____________________ ☐ No evidence of excessive growth ☐ Vegetation in channels does not obstruct flow ☐ Location shown on site map Areal extent______________ Remarks____
D. Cover Penetrations x Applicable ☐ N/A	
1.	**Gas Vents** ☐ Active x Passive ☐ Properly secured/locked x Functioning ☐ Routinely sampled x Good condition ☐ Evidence of leakage at penetration ☐ Needs Maintenance ☐ N/A Remarks____
2.	**Gas Monitoring Probes** x Properly secured/locked x Functioning x Routinely sampled x Good condition ☐ Evidence of leakage at penetration ☐ Needs Maintenance ☐ N/A Remarks____
3.	**Monitoring Wells** (within surface area of landfill) x Properly secured/locked x Functioning x Routinely sampled x Good condition ☐ Evidence of leakage at penetration ☐ Needs Maintenance ☐ N/A Remarks____
4.	**Leachate Extraction Wells** ☐ Properly secured/locked ☐ Functioning ☐ Routinely sampled ☐ Good condition ☐ Evidence of leakage at penetration ☐ Needs Maintenance x N/A Remarks____
5.	**Settlement Monuments** ☐ Located x Routinely surveyed ☐ N/A Remarks____

E. Gas Collection and Treatment ☐ Applicable x N/A
1. **Gas Treatment Facilities** ☐ Flaring ☐ Thermal destruction ☐ Collection for reuse ☐ Good condition ☐ Needs Maintenance Remarks____
2. **Gas Collection Wells, Manifolds and Piping** ☐ Good condition ☐ Needs Maintenance Remarks____
3. **Gas Monitoring Facilities** (*e.g.*, gas monitoring of adjacent homes or buildings) ☐ Good condition ☐ Needs Maintenance ☐ N/A Remarks____
F. Cover Drainage Layer ☐ Applicable x N/A
1. **Outlet Pipes Inspected** ☐ Functioning ☐ N/A Remarks____
2. **Outlet Rock Inspected** ☐ Functioning ☐ N/A Remarks____
G. Detention/Sedimentation Ponds x Applicable ☐ N/A
1. **Siltation** Areal extent______________ Depth____________ x N/A ☐ Siltation not evident Remarks____
2. **Erosion** Areal extent______________ Depth____________ x Erosion not evident Remarks____
3. **Outlet Works** ☐ Functioning x N/A Remarks____
4. **Dam** ☐ Functioning x N/A Remarks____

H. Retaining Walls	☐ Applicable x N/A
1. **Deformations** ☐ Location shown on site map ☐ Deformation not evident Horizontal displacement__________ Vertical displacement____________ Rotational displacement__________ Remarks____	
2. **Degradation** ☐ Location shown on site map ☐ Degradation not evident Remarks____	
I. Perimeter Ditches/Off-Site Discharge	x Applicable ☐ N/A
1. **Siltation** ☐ Location shown on site map x Siltation not evident Areal extent__________ Depth__________ Remarks____	
2. **Vegetative Growth** ☐ Location shown on site map ☐ N/A x Vegetation does not impede flow Areal extent__________ Type__________ Remarks____	
3. **Erosion** ☐ Location shown on site map x Erosion not evident Areal extent__________ Depth__________ Remarks____	
4. **Discharge Structure** ☐ Functioning x N/A Remarks____	
VIII. VERTICAL BARRIER WALLS	☐ Applicable x N/A
1. **Settlement** ☐ Location shown on site map ☐ Settlement not evident Areal extent__________ Depth__________ Remarks____	
2. **Performance Monitoring** Type of monitoring____________________ ☐ Performance not monitored Frequency________________________ ☐ Evidence of breaching Head differential____________________ Remarks____	

IX. GROUNDWATER/SURFACE WATER REMEDIES ☐ Applicable x N/A
A. Groundwater Extraction Wells, Pumps, and Pipelines ☐ Applicable ☐ N/A
1. **Pumps, Wellhead Plumbing, and Electrical** ☐ Good condition ☐ All required wells properly operating ☐ Needs Maintenance ☐ N/A Remarks______________________________
2. **Extraction System Pipelines, Valves, Valve Boxes, and Other Appurtenances** ☐ Good condition ☐ Needs Maintenance Remarks______________________________
3. **Spare Parts and Equipment** ☐ Readily available ☐ Good condition ☐ Requires upgrade ☐ Needs to be provided Remarks______________________________
B. Surface Water Collection Structures, Pumps, and Pipelines ☐ Applicable ☐ N/A
1. **Collection Structures, Pumps, and Electrical** ☐ Good condition ☐ Needs Maintenance Remarks______________________________
2. **Surface Water Collection System Pipelines, Valves, Valve Boxes, and Other Appurtenances** ☐ Good condition ☐ Needs Maintenance Remarks______________________________
3. **Spare Parts and Equipment** ☐ Readily available ☐ Good condition ☐ Requires upgrade ☐ Needs to be provided Remarks______________________________

C. Treatment System ☐ Applicable ☐ N/A
1. **Treatment Train** (Check components that apply) ☐ Metals removal ☐ Oil/water separation ☐ Bioremediation ☐ Air stripping ☐ Carbon adsorbers ☐ Filters____________________ ☐ Additive (*e.g.*, chelation agent, flocculent)____________________ ☐ Others____________________ ☐ Good condition ☐ Needs Maintenance ☐ Sampling ports properly marked and functional ☐ Sampling/maintenance log displayed and up to date ☐ Equipment properly identified ☐ Quantity of groundwater treated annually____________ ☐ Quantity of surface water treated annually____________ Remarks____________________ ____________________
2. **Electrical Enclosures and Panels** (properly rated and functional) ☐ N/A ☐ Good condition ☐ Needs Maintenance Remarks____________________ ____________________
3. **Tanks, Vaults, Storage Vessels** ☐ N/A ☐ Good condition ☐ Proper secondary containment ☐ Needs Maintenance Remarks____________________ ____________________
4. **Discharge Structure and Appurtenances** ☐ N/A ☐ Good condition ☐ Needs Maintenance Remarks____________________ ____________________
5. **Treatment Building(s)** ☐ N/A ☐ Good condition (esp. roof and doorways) ☐ Needs repair ☐ Chemicals and equipment properly stored Remarks____________________ ____________________
6. **Monitoring Wells** (pump and treatment remedy) ☐ Properly secured/locked ☐ Functioning ☐ Routinely sampled ☐ Good condition ☐ All required wells located ☐ Needs Maintenance ☐ N/A Remarks____________________ ____________________
D. Monitoring Data
1. Monitoring Data ☐ Is routinely submitted on time ☐ Is of acceptable quality
2. Monitoring data suggests: ☐ Groundwater plume is effectively contained ☐ Contaminant concentrations are declining

D. Monitored Natural Attenuation	
1.	**Monitoring Wells** (natural attenuation remedy) ☐ Properly secured/locked ☐ Functioning ☐ Routinely sampled ☐ Good condition ☐ All required wells located ☐ Needs Maintenance ☐ N/A Remarks____ ____
X. OTHER REMEDIES	
If there are remedies applied at the site which are not covered above, attach an inspection sheet describing the physical nature and condition of any facility associated with the remedy. An example would be soil vapor extraction. **Not Applicable**	
XI. OVERALL OBSERVATIONS	
A.	**Implementation of the Remedy**
	Describe issues and observations relating to whether the remedy is effective and functioning as designed. Begin with a brief statement of what the remedy is to accomplish (i.e., to contain contaminant plume, minimize infiltration and gas emission, etc.). **Annual Landfill Inspections are being conducted, no change in land use, minor fence repair and landfill cap erosion repair has been performed, fence and signs are in good condition, landfill cap has not settled and is in good condition.**
B.	**Adequacy of O&M**
	Describe issues and observations related to the implementation and scope of O&M procedures. In particular, discuss their relationship to the current and long-term protectiveness of the remedy. **Not Applicable**
C.	**Early Indicators of Potential Remedy Problems**
	Describe issues and observations such as unexpected changes in the cost or scope of O&M or a high frequency of unscheduled repairs, that suggest that the protectiveness of the remedy may be compromised in the future. **None**
D.	**Opportunities for Optimization**
	Describe possible opportunities for optimization in monitoring tasks or the operation of the remedy. **None**

LF-1 Photo 1: LF-1 landfill fence

LF-1 Photo 2: LF-1 landfill sign

LF-1 photo 3: LF-1 landfill cap

LF-1 Photo 4: LF-1 landfill cap

LF-1 Photo 5: LF-1 landfill cap

LF-7 Site Inspection

Five-Year Review Site Inspection Checklist

I. SITE INFORMATION	
Site name: Landfill-7	**Date of inspection: 6/19/13**
Location and Region: In a former gravel pit north of the LF-1 source area	**EPA ID:** MA2570024487
Agency, office, or company leading the five-year review: AFCEC	**Weather/temperature: Sunny, clear, 70's**

Remedy Includes: (Check all that apply)

- ☐ Landfill cover/containment
- ☐ Access controls
- x Institutional controls
- ☐ Groundwater pump and treatment
- ☐ Surface water collection and treatment
- x Other: **Fence and Annual Inspections**
- ☐ Monitored natural attenuation
- ☐ Groundwater containment
- ☐ Vertical barrier walls

Attachments: ☐ Inspection team roster attached ☐ Site map attached **See Figure 4-5**

II. INTERVIEWS Not conducted since no ongoing O&M (See Section 3.6)

1. **O&M site manager** ______________________________ ________________________ _____________
Name Title Date
Interviewed ☐ at site ☐ at office ☐ by phone Phone no. _______________
Problems, suggestions; ☐ Report attached ☐ ____

2. **O&M staff** ______________________________ ________________________ _____________
Name Title Date
Interviewed ☐ at site ☐ at office ☐ by phone Phone no. _______________
Problems, suggestions; ☐ Report attached ____

3.	**Local regulatory authorities and response agencies** (i.e., State and Tribal offices, emergency response office, police department, office of public health or environmental health, zoning office, recorder of deeds, or other city and county offices, etc.) Fill in all that apply. Agency ______________________________ Contact ______________________________ ___________________ ________ ____________ Name Title Date Phone no. Problems; suggestions; ☐ Report attached ____________________ Agency ______________________________ Contact ______________________________ ___________________ ________ ____________ Name Title Date Phone no. Problems; suggestions; ☐ Report attached ____________________ Agency ______________________________ Contact ______________________________ ___________________ ________ ____________ Name Title Date Phone no. Problems; suggestions; ☐ Report attached ____________________ Agency ______________________________ Contact ______________________________ ___________________ ________ ____________ Name Title Date Phone no. Problems; suggestions; ☐ Report attached ____________________
4.	**Other interviews** (optional) ☐ Report attached.
None	

III. ON-SITE DOCUMENTS & RECORDS VERIFIED (Check all that apply)				
1.	**O&M Documents**			
	☐ O&M manual	☐ Readily available	☐ Up to date	x N/A
	☐ As-built drawings	☐ Readily available	☐ Up to date	x N/A
	☐ Maintenance logs	☐ Readily available	☐ Up to date	x N/A
	Remarks			
2.	**Site-Specific Health and Safety Plan**	x Readily available	x Up to date	☐ N/A
	☐ Contingency plan/emergency response plan	x Readily available	x Up to date	☐ N/A
	Remarks			
3.	**O&M and OSHA Training Records**	☐ Readily available	☐ Up to date	x N/A
	Remarks			
4.	**Permits and Service Agreements**			
	☐ Air discharge permit	☐ Readily available	☐ Up to date	x N/A
	☐ Effluent discharge	☐ Readily available	☐ Up to date	x N/A
	☐ Waste disposal, POTW	☐ Readily available	☐ Up to date	x N/A
	☐ Other permits	☐ Readily available	☐ Up to date	x N/A
	Remarks			
5.	**Gas Generation Records**	☐ Readily available	☐ Up to date	x N/A
	Remarks			
6.	**Settlement Monument Records**	☐ Readily available	☐ Up to date	x N/A
	Remarks			
7.	**Groundwater Monitoring Records**	☐ Readily available	☐ Up to date	x N/A
	Remarks			
8.	**Leachate Extraction Records**	☐ Readily available	☐ Up to date	x N/A
	Remarks			
9.	**Discharge Compliance Records**			
	☐ Air	☐ Readily available	☐ Up to date	x N/A
	☐ Water (effluent)	☐ Readily available	☐ Up to date	x N/A
	Remarks			
10.	**Daily Access/Security Logs**	☐ Readily available	☐ Up to date	x N/A
	Remarks			

IV. O&M COSTS: Not Applicable	
1.	**O&M Organization** ☐ State in-house ☐ Contractor for State ☐ PRP in-house ☐ Contractor for PRP ☐ Federal Facility in-house ☐ Contractor for Federal Facility ☐ Other____
2.	**O&M Cost Records** ☐ Readily available ☐ Up to date ☐ Funding mechanism/agreement in place Original O&M cost estimate________________ ☐ Breakdown attached Total annual cost by year for review period if available From______ To______ __________ ☐ Breakdown attached Date Date Total cost From______ To______ __________ ☐ Breakdown attached Date Date Total cost From______ To______ __________ ☐ Breakdown attached Date Date Total cost From______ To______ __________ ☐ Breakdown attached Date Date Total cost From______ To______ __________ ☐ Breakdown attached Date Date Total cost
3.	**Unanticipated or Unusually High O&M Costs During Review Period** Describe costs and reasons: ________________________

V. ACCESS AND INSTITUTIONAL CONTROLS x Applicable ☐ N/A	
A. Fencing	
1.	**Fencing damaged** ☐ Location shown on site map x Gates secured ☐ N/A Remark: **Fence in good condition (see photo #1)**
B. Other Access Restrictions	
1.	**Signs and other security measures** ☐ Location shown on site map ☐ N/A Remarks: **Signs in place (see photo #2)**

C. Institutional Controls (ICs)	
1.	**Implementation and enforcement** Site conditions imply ICs not properly implemented ☐ Yes x No ☐ N/A Site conditions imply ICs not being fully enforced ☐ Yes x No ☐ N/A Type of monitoring (*e.g.*, self-reporting, drive by): **Inspections and Radiological Surveys** Frequency: **Annual** Responsible party/agency: **AFCEC** Contact: **Jon Davis** (Name) **AFCEC PM** (Title) **6/19/13** (Date) **(508) 968-4670 (ext 4952)** (Phone no.) Reporting is up-to-date x Yes ☐ No ☐ N/A Reports are verified by the lead agency x Yes ☐ No ☐ N/A Specific requirements in deed or decision documents have been met x Yes ☐ No ☐ N/A Violations have been reported ☐ Yes x No ☐ N/A Other problems or suggestions: ☐ Report attached
2.	**Adequacy** x ICs are adequate ☐ ICs are inadequate ☐ N/A Remarks
D. General	
1.	**Vandalism/trespassing** ☐ Location shown on site map x No vandalism evident Remarks
2.	**Land use changes on site** ☐ N/A Remarks: **None**
3.	**Land use changes off site** x N/A Remarks
VI. GENERAL SITE CONDITIONS	
A. Roads ☐ Applicable x N/A	
1.	**Roads damaged** ☐ Location shown on site map ☐ Roads adequate x N/A Remarks

B. Other Site Conditions

Remarks _**None**____

VII. LANDFILL COVERS ☐ Applicable x N/A

A. Landfill Surface

1. **Settlement** (Low spots) ☐ Location shown on site map ☐ Settlement not evident
   Areal extent______________ Depth____________
   Remarks____

2. **Cracks** ☐ Location shown on site map ☐ Cracking not evident
   Lengths____________ Widths___________ Depths__________
   Remarks____

3. **Erosion** ☐ Location shown on site map ☐ Erosion not evident
   Areal extent______________ Depth____________
   Remarks____

4. **Holes** ☐ Location shown on site map ☐ Holes not evident
   Areal extent______________ Depth____________
   Remarks____

5. **Vegetative Cover** ☐ Grass ☐ Cover properly established ☐ No signs of stress
   ☐ Trees/Shrubs (indicate size and locations on a diagram)
   Remarks____

6. **Alternative Cover (armored rock, concrete, etc.)** ☐ N/A
   Remarks____

7. **Bulges** ☐ Location shown on site map ☐ Bulges not evident
   Areal extent______________ Height____________
   Remarks____

8. **Wet Areas/Water Damage** ☐ Wet areas/water damage not evident ☐ Wet areas ☐ Location shown on site map Areal extent______________ ☐ Ponding ☐ Location shown on site map Areal extent______________ ☐ Seeps ☐ Location shown on site map Areal extent______________ ☐ Soft subgrade ☐ Location shown on site map Areal extent______________ Remarks____ ____	
9. **Slope Instability** ☐ Slides ☐ Location shown on site map ☐ No evidence of slope instability Areal extent______________ Remarks____ ____	
B. Benches ☐ Applicable ☐ N/A (Horizontally constructed mounds of earth placed across a steep landfill side slope to interrupt the slope in order to slow down the velocity of surface runoff and intercept and convey the runoff to a lined channel.)	
1. **Flows Bypass Bench** ☐ Location shown on site map ☐ N/A or okay Remarks____ ____	
2. **Bench Breached** ☐ Location shown on site map ☐ N/A or okay Remarks____ ____	
3. **Bench Overtopped** ☐ Location shown on site map ☐ N/A or okay Remarks____ ____	
C. Letdown Channels ☐ Applicable ☐ N/A (Channel lined with erosion control mats, riprap, grout bags, or gabions that descend down the steep side slope of the cover and will allow the runoff water collected by the benches to move off of the landfill cover without creating erosion gullies.)	
1. **Settlement** ☐ Location shown on site map ☐ No evidence of settlement Areal extent______________ Depth____________ Remarks____ ____	
2. **Material Degradation** ☐ Location shown on site map ☐ No evidence of degradation Material type_______________ Areal extent_____________ Remarks____ ____	
3. **Erosion** ☐ Location shown on site map ☐ No evidence of erosion Areal extent______________ Depth____________ Remarks____ ____	

4.	**Undercutting** ☐ Location shown on site map ☐ No evidence of undercutting Areal extent______________ Depth____________ Remarks____ ____	
5.	**Obstructions** Type_____________________ ☐ No obstructions ☐ Location shown on site map Areal extent______________ Size____________ Remarks____ ____	
6.	**Excessive Vegetative Growth** Type____________________ ☐ No evidence of excessive growth ☐ Vegetation in channels does not obstruct flow ☐ Location shown on site map Areal extent______________ Remarks____ ____	
D. Cover Penetrations ☐ Applicable ☐ N/A		
1.	**Gas Vents** ☐ Active ☐ Passive ☐ Properly secured/locked ☐ Functioning ☐ Routinely sampled ☐ Good condition ☐ Evidence of leakage at penetration ☐ Needs Maintenance ☐ N/A Remarks____ ____	
2.	**Gas Monitoring Probes** ☐ Properly secured/locked ☐ Functioning ☐ Routinely sampled ☐ Good condition ☐ Evidence of leakage at penetration ☐ Needs Maintenance ☐ N/A Remarks____ ____	
3.	**Monitoring Wells** (within surface area of landfill) ☐ Properly secured/locked ☐ Functioning ☐ Routinely sampled ☐ Good condition ☐ Evidence of leakage at penetration ☐ Needs Maintenance ☐ N/A Remarks____ ____	
4.	**Leachate Extraction Wells** ☐ Properly secured/locked ☐ Functioning ☐ Routinely sampled ☐ Good condition ☐ Evidence of leakage at penetration ☐ Needs Maintenance ☐ N/A Remarks____ ____	
5.	**Settlement Monuments** ☐ Located ☐ Routinely surveyed ☐ N/A Remarks____ ____	

E. Gas Collection and Treatment ☐ Applicable ☐ N/A	
1.	**Gas Treatment Facilities** ☐ Flaring ☐ Thermal destruction ☐ Collection for reuse ☐ Good condition ☐ Needs Maintenance Remarks____
2.	**Gas Collection Wells, Manifolds and Piping** ☐ Good condition ☐ Needs Maintenance Remarks____
3.	**Gas Monitoring Facilities** (*e.g.*, gas monitoring of adjacent homes or buildings) ☐ Good condition ☐ Needs Maintenance ☐ N/A Remarks____
F. Cover Drainage Layer ☐ Applicable ☐ N/A	
1.	**Outlet Pipes Inspected** ☐ Functioning ☐ N/A Remarks____
2.	**Outlet Rock Inspected** ☐ Functioning ☐ N/A Remarks____
G. Detention/Sedimentation Ponds ☐ Applicable ☐ N/A	
1.	**Siltation** Areal extent______________ Depth____________ ☐ N/A ☐ Siltation not evident Remarks____
2.	**Erosion** Areal extent______________ Depth____________ ☐ Erosion not evident Remarks____
3.	**Outlet Works** ☐ Functioning ☐ N/A Remarks____
4.	**Dam** ☐ Functioning ☐ N/A Remarks____

H. Retaining Walls ☐ Applicable ☐ N/A	
1.	**Deformations** ☐ Location shown on site map ☐ Deformation not evident Horizontal displacement____________ Vertical displacement_______________ Rotational displacement____________ Remarks____ ____
2.	**Degradation** ☐ Location shown on site map ☐ Degradation not evident Remarks____ ____
I. Perimeter Ditches/Off-Site Discharge ☐ Applicable ☐ N/A	
1.	**Siltation** ☐ Location shown on site map ☐ Siltation not evident Areal extent______________ Depth____________ Remarks____ ____
2.	**Vegetative Growth** ☐ Location shown on site map ☐ N/A ☐ Vegetation does not impede flow Areal extent______________ Type____________ Remarks____ ____
3.	**Erosion** ☐ Location shown on site map ☐ Erosion not evident Areal extent______________ Depth____________ Remarks____ ____
4.	**Discharge Structure** ☐ Functioning ☐ N/A Remarks____ ____
VIII. VERTICAL BARRIER WALLS ☐ Applicable x N/A	
1.	**Settlement** ☐ Location shown on site map ☐ Settlement not evident Areal extent______________ Depth____________ Remarks____ ____
2.	**Performance Monitoring** Type of monitoring__________________________ ☐ Performance not monitored Frequency________________________________ ☐ Evidence of breaching Head differential__________________________ Remarks____ ____

IX. GROUNDWATER/SURFACE WATER REMEDIES ☐ Applicable x N/A
A. Groundwater Extraction Wells, Pumps, and Pipelines ☐ Applicable ☐ N/A
1. **Pumps, Wellhead Plumbing, and Electrical** ☐ Good condition ☐ All required wells properly operating ☐ Needs Maintenance ☐ N/A Remarks______________________________
2. **Extraction System Pipelines, Valves, Valve Boxes, and Other Appurtenances** ☐ Good condition ☐ Needs Maintenance Remarks______________________________
3. **Spare Parts and Equipment** ☐ Readily available ☐ Good condition ☐ Requires upgrade ☐ Needs to be provided Remarks______________________________
B. Surface Water Collection Structures, Pumps, and Pipelines ☐ Applicable ☐ N/A
1. **Collection Structures, Pumps, and Electrical** ☐ Good condition ☐ Needs Maintenance Remarks______________________________
2. **Surface Water Collection System Pipelines, Valves, Valve Boxes, and Other Appurtenances** ☐ Good condition ☐ Needs Maintenance Remarks______________________________
3. **Spare Parts and Equipment** ☐ Readily available ☐ Good condition ☐ Requires upgrade ☐ Needs to be provided Remarks______________________________

C. Treatment System ☐ Applicable ☐ N/A
1. **Treatment Train** (Check components that apply) ☐ Metals removal ☐ Oil/water separation ☐ Bioremediation ☐ Air stripping ☐ Carbon adsorbers ☐ Filters____________________ ☐ Additive (*e.g.*, chelation agent, flocculent)____________________ ☐ Others____________________ ☐ Good condition ☐ Needs Maintenance ☐ Sampling ports properly marked and functional ☐ Sampling/maintenance log displayed and up to date ☐ Equipment properly identified ☐ Quantity of groundwater treated annually____________________ ☐ Quantity of surface water treated annually____________________ Remarks____________________
2. **Electrical Enclosures and Panels** (properly rated and functional) ☐ N/A ☐ Good condition ☐ Needs Maintenance Remarks____________________
3. **Tanks, Vaults, Storage Vessels** ☐ N/A ☐ Good condition ☐ Proper secondary containment ☐ Needs Maintenance Remarks____________________
4. **Discharge Structure and Appurtenances** ☐ N/A ☐ Good condition ☐ Needs Maintenance Remarks____________________
5. **Treatment Building(s)** ☐ N/A ☐ Good condition (esp. roof and doorways) ☐ Needs repair ☐ Chemicals and equipment properly stored Remarks____________________
6. **Monitoring Wells** (pump and treatment remedy) ☐ Properly secured/locked ☐ Functioning ☐ Routinely sampled ☐ Good condition ☐ All required wells located ☐ Needs Maintenance ☐ N/A Remarks____________________
D. Monitoring Data
1. Monitoring Data ☐ Is routinely submitted on time ☐ Is of acceptable quality
2. Monitoring data suggests: ☐ Groundwater plume is effectively contained ☐ Contaminant concentrations are declining

D. Monitored Natural Attenuation

1. **Monitoring Wells** (natural attenuation remedy)
☐ Properly secured/locked ☐ Functioning ☐ Routinely sampled ☐ Good condition
☐ All required wells located ☐ Needs Maintenance ☐ N/A
Remarks____
____

X. OTHER REMEDIES

If there are remedies applied at the site which are not covered above, attach an inspection sheet describing the physical nature and condition of any facility associated with the remedy. An example would be soil vapor extraction. **Not Applicable**

XI. OVERALL OBSERVATIONS

A. Implementation of the Remedy

Describe issues and observations relating to whether the remedy is effective and functioning as designed. Begin with a brief statement of what the remedy is to accomplish (i.e., to contain contaminant plume, minimize infiltration and gas emission, etc.).

Annual Inspections being conducted, no change in land use, no issues with fence.

B. Adequacy of O&M

Describe issues and observations related to the implementation and scope of O&M procedures. In particular, discuss their relationship to the current and long-term protectiveness of the remedy.

Not Applicable

C. Early Indicators of Potential Remedy Problems

Describe issues and observations such as unexpected changes in the cost or scope of O&M or a high frequency of unscheduled repairs, that suggest that the protectiveness of the remedy may be compromised in the future.

None

D. Opportunities for Optimization

Describe possible opportunities for optimization in monitoring tasks or the operation of the remedy.

None

LF-7 photo #1: LF-7 Fence

LF-7 Photo #2: LF-7 Sign

PFSA (FS-10/FS-11) Site Inspection

Five-Year Review Site Inspection Checklist

I. SITE INFORMATION	
Site name: Petroleum Fuel Storage Area (PFSA)	**Date of inspection: 7/10/13**
Location and Region: North side of South Outer Road.	**EPA ID:** MA2570024487
Agency, office, or company leading the five-year review: AFCEC	**Weather/temperature: 80's, overcast, light wind**

Remedy Includes: (Check all that apply)

- ☐ Landfill cover/containment
- ☐ Access controls
- x Institutional controls
- ☐ Groundwater pump and treatment
- ☐ Surface water collection and treatment
- ☐ Other____
- ☐ Monitored natural attenuation
- ☐ Groundwater containment
- ☐ Vertical barrier walls

Attachments: ☐ Inspection team roster attached ☐ Site map attached **See Figure 4-6**

II. INTERVIEWS (Check all that apply) **Not conducted since no ongoing O&M (See Section 3.6)**

1. **O&M site manager** ______________________ ______________________ ____________
   Name Title Date
   Interviewed ☐ at site ☐ at office ☐ by phone Phone no. _______________
   Problems, suggestions; ☐ Report attached ☐ ____

2. **O&M staff** ______________________ ______________________ ____________
   Name Title Date
   Interviewed ☐ at site ☐ at office ☐ by phone Phone no. _______________
   Problems, suggestions; ☐ Report attached ____

3.	**Local regulatory authorities and response agencies** (i.e., State and Tribal offices, emergency response office, police department, office of public health or environmental health, zoning office, recorder of deeds, or other city and county offices, etc.) Fill in all that apply. Agency ______________________________ Contact ______________________________ ___________________ _________ _____________ Name Title Date Phone no. Problems; suggestions; ☐ Report attached ____ Agency ______________________________ Contact ______________________________ ___________________ _________ _____________ Name Title Date Phone no. Problems; suggestions; ☐ Report attached ____ Agency ______________________________ Contact ______________________________ ___________________ _________ _____________ Name Title Date Phone no. Problems; suggestions; ☐ Report attached ____ Agency ______________________________ Contact ______________________________ ___________________ _________ _____________ Name Title Date Phone no. Problems; suggestions; ☐ Report attached ____
4.	**Other interviews** (optional) ☐ Report attached.
None	

III. ON-SITE DOCUMENTS & RECORDS VERIFIED (Check all that apply)				
1.	**O&M Documents**			
	☐ O&M manual	☐ Readily available	☐ Up to date	x N/A
	☐ As-built drawings	☐ Readily available	☐ Up to date	x N/A
	☐ Maintenance logs	☐ Readily available	☐ Up to date	x N/A
	Remarks_______________			
2.	**Site-Specific Health and Safety Plan**	x Readily available	x Up to date	☐ N/A
	☐ Contingency plan/emergency response plan	x Readily available	x Up to date	☐ N/A
	Remarks_______________			
3.	**O&M and OSHA Training Records**	☐ Readily available	☐ Up to date	x N/A
	Remarks_______________			
4.	**Permits and Service Agreements**			
	☐ Air discharge permit	☐ Readily available	☐ Up to date	x N/A
	☐ Effluent discharge	☐ Readily available	☐ Up to date	x N/A
	☐ Waste disposal, POTW	☐ Readily available	☐ Up to date	x N/A
	☐ Other permits_______________	☐ Readily available	☐ Up to date	x N/A
	Remarks_______________			
5.	**Gas Generation Records**	☐ Readily available	☐ Up to date	x N/A
	Remarks_______________			
6.	**Settlement Monument Records**	☐ Readily available	☐ Up to date	x N/A
	Remarks_______________			
7.	**Groundwater Monitoring Records**	☐ Readily available	☐ Up to date	x N/A
	Remarks_______________			
8.	**Leachate Extraction Records**	☐ Readily available	☐ Up to date	x N/A
	Remarks_______________			
9.	**Discharge Compliance Records**			
	☐ Air	☐ Readily available	☐ Up to date	x N/A
	☐ Water (effluent)	☐ Readily available	☐ Up to date	x N/A
	Remarks_______________			
10.	**Daily Access/Security Logs**	☐ Readily available	☐ Up to date	x N/A
	Remarks_______________			

IV. O&M COSTS Not Applicable	
1.	**O&M Organization** ☐ State in-house ☐ Contractor for State ☐ PRP in-house ☐ Contractor for PRP ☐ Federal Facility in-house ☐ Contractor for Federal Facility ☐ Other____
2.	**O&M Cost Records** ☐ Readily available ☐ Up to date ☐ Funding mechanism/agreement in place Original O&M cost estimate____________________ ☐ Breakdown attached Total annual cost by year for review period if available From__________ To__________ __________________ ☐ Breakdown attached Date Date Total cost From__________ To__________ __________________ ☐ Breakdown attached Date Date Total cost From__________ To__________ __________________ ☐ Breakdown attached Date Date Total cost From__________ To__________ __________________ ☐ Breakdown attached Date Date Total cost From__________ To__________ __________________ ☐ Breakdown attached Date Date Total cost
3.	**Unanticipated or Unusually High O&M Costs During Review Period** Describe costs and reasons: ____

V. ACCESS AND INSTITUTIONAL CONTROLS ☐ Applicable x N/A	
A. Fencing	
1.	**Fencing damaged** ☐ Location shown on site map ☐ Gates secured ☐ N/A Remarks____
B. Other Access Restrictions	
1.	**Signs and other security measures** ☐ Location shown on site map ☐ N/A Remarks____

C. Institutional Controls (ICs)

1. **Implementation and enforcement**
Site conditions imply ICs not properly implemented ☐ Yes ☐ No ☐ N/A
Site conditions imply ICs not being fully enforced ☐ Yes ☐ No ☐ N/A

Type of monitoring (*e.g.*, self-reporting, drive by) ________________________________
Frequency ________________________________
Responsible party/agency ________________________________
Contact ________________ ________________ ________ ________
Name Title Date Phone no.

Reporting is up-to-date ☐ Yes ☐ No ☐ N/A
Reports are verified by the lead agency ☐ Yes ☐ No ☐ N/A

Specific requirements in deed or decision documents have been met ☐ Yes ☐ No ☐ N/A
Violations have been reported ☐ Yes ☐ No ☐ N/A
Other problems or suggestions: ☐ Report attached

____
____
____
____

2. **Adequacy** ☐ ICs are adequate ☐ ICs are inadequate ☐ N/A
Remarks________________________________
____
____

D. General

1. **Vandalism/trespassing** ☐ Location shown on site map ☐ No vandalism evident
Remarks________________________________
____

2. **Land use changes on site** ☐ N/A
Remarks________________________________
____

3. **Land use changes off site** ☐ N/A
Remarks________________________________
____

VI. GENERAL SITE CONDITIONS

A. Roads ☐ Applicable ☐ N/A

1. **Roads damaged** ☐ Location shown on site map ☐ Roads adequate x N/A
Remarks________________________________
____

B. Other Site Conditions
Remarks **None**

	VII. LANDFILL COVERS ☐ Applicable x N/A
A. Landfill Surface	
1.	**Settlement** (Low spots) ☐ Location shown on site map ☐ Settlement not evident Areal extent______________ Depth____________ Remarks____ ____
2.	**Cracks** ☐ Location shown on site map ☐ Cracking not evident Lengths____________ Widths___________ Depths__________ Remarks____ ____
3.	**Erosion** ☐ Location shown on site map ☐ Erosion not evident Areal extent______________ Depth____________ Remarks____ ____
4.	**Holes** ☐ Location shown on site map ☐ Holes not evident Areal extent______________ Depth____________ Remarks____ ____
5.	**Vegetative Cover** ☐ Grass ☐ Cover properly established ☐ No signs of stress ☐ Trees/Shrubs (indicate size and locations on a diagram) Remarks____ ____
6.	**Alternative Cover (armored rock, concrete, etc.)** ☐ N/A Remarks____ ____
7.	**Bulges** ☐ Location shown on site map ☐ Bulges not evident Areal extent______________ Height____________ Remarks____ ____
8.	**Wet Areas/Water Damage** ☐ Wet areas/water damage not evident ☐ Wet areas ☐ Location shown on site map Areal extent______________ ☐ Ponding ☐ Location shown on site map Areal extent______________ ☐ Seeps ☐ Location shown on site map Areal extent______________ ☐ Soft subgrade ☐ Location shown on site map Areal extent______________ Remarks____ ____

9.	**Slope Instability** ☐ Slides ☐ Location shown on site map ☐ No evidence of slope instability Areal extent_______________ Remarks____ ____
B. Benches	☐ Applicable ☐ N/A (Horizontally constructed mounds of earth placed across a steep landfill side slope to interrupt the slope in order to slow down the velocity of surface runoff and intercept and convey the runoff to a lined channel.)
1.	**Flows Bypass Bench** ☐ Location shown on site map ☐ N/A or okay Remarks____ ____
2.	**Bench Breached** ☐ Location shown on site map ☐ N/A or okay Remarks____ ____
3.	**Bench Overtopped** ☐ Location shown on site map ☐ N/A or okay Remarks____ ____
C. Letdown Channels	☐ Applicable ☐ N/A (Channel lined with erosion control mats, riprap, grout bags, or gabions that descend down the steep side slope of the cover and will allow the runoff water collected by the benches to move off of the landfill cover without creating erosion gullies.)
1.	**Settlement** ☐ Location shown on site map ☐ No evidence of settlement Areal extent_______________ Depth____________ Remarks____ ____
2.	**Material Degradation** ☐ Location shown on site map ☐ No evidence of degradation Material type________________ Areal extent______________ Remarks____ ____
3.	**Erosion** ☐ Location shown on site map ☐ No evidence of erosion Areal extent_______________ Depth____________ Remarks____ ____

4.	**Undercutting** ☐ Location shown on site map ☐ No evidence of undercutting Areal extent______________ Depth____________ Remarks____ ____	
5.	**Obstructions** Type_____________________ ☐ No obstructions ☐ Location shown on site map Areal extent______________ Size____________ Remarks____ ____	
6.	**Excessive Vegetative Growth** Type____________________ ☐ No evidence of excessive growth ☐ Vegetation in channels does not obstruct flow ☐ Location shown on site map Areal extent______________ Remarks____ ____	
D. Cover Penetrations ☐ Applicable ☐ N/A		
1.	**Gas Vents** ☐ Active ☐ Passive ☐ Properly secured/locked ☐ Functioning ☐ Routinely sampled ☐ Good condition ☐ Evidence of leakage at penetration ☐ Needs Maintenance ☐ N/A Remarks____ ____	
2.	**Gas Monitoring Probes** ☐ Properly secured/locked ☐ Functioning ☐ Routinely sampled ☐ Good condition ☐ Evidence of leakage at penetration ☐ Needs Maintenance ☐ N/A Remarks____ ____	
3.	**Monitoring Wells** (within surface area of landfill) ☐ Properly secured/locked ☐ Functioning ☐ Routinely sampled ☐ Good condition ☐ Evidence of leakage at penetration ☐ Needs Maintenance ☐ N/A Remarks____ ____	
4.	**Leachate Extraction Wells** ☐ Properly secured/locked ☐ Functioning ☐ Routinely sampled ☐ Good condition ☐ Evidence of leakage at penetration ☐ Needs Maintenance ☐ N/A Remarks____ ____	
5.	**Settlement Monuments** ☐ Located ☐ Routinely surveyed ☐ N/A Remarks____ ____	

E. **Gas Collection and Treatment** ☐ Applicable ☐ N/A	
1.	**Gas Treatment Facilities** ☐ Flaring ☐ Thermal destruction ☐ Collection for reuse ☐ Good condition ☐ Needs Maintenance Remarks____ ____
2.	**Gas Collection Wells, Manifolds and Piping** ☐ Good condition ☐ Needs Maintenance Remarks____ ____
3.	**Gas Monitoring Facilities** (*e.g.*, gas monitoring of adjacent homes or buildings) ☐ Good condition ☐ Needs Maintenance ☐ N/A Remarks____ ____
F. Cover Drainage Layer ☐ Applicable ☐ N/A	
1.	**Outlet Pipes Inspected** ☐ Functioning ☐ N/A Remarks____ ____
2.	**Outlet Rock Inspected** ☐ Functioning ☐ N/A Remarks____ ____
G. Detention/Sedimentation Ponds ☐ Applicable ☐ N/A	
1.	**Siltation** Areal extent______________ Depth____________ ☐ N/A ☐ Siltation not evident Remarks____ ____
2.	**Erosion** Areal extent______________ Depth____________ ☐ Erosion not evident Remarks____ ____
3.	**Outlet Works** ☐ Functioning ☐ N/A Remarks____ ____
4.	**Dam** ☐ Functioning ☐ N/A Remarks____ ____

H. Retaining Walls ☐ Applicable ☐ N/A	
1.	**Deformations** ☐ Location shown on site map ☐ Deformation not evident Horizontal displacement_____________ Vertical displacement________________ Rotational displacement_____________ Remarks____ ____
2.	**Degradation** ☐ Location shown on site map ☐ Degradation not evident Remarks____ ____
I. Perimeter Ditches/Off-Site Discharge ☐ Applicable ☐ N/A	
1.	**Siltation** ☐ Location shown on site map ☐ Siltation not evident Areal extent_______________ Depth_____________ Remarks____ ____
2.	**Vegetative Growth** ☐ Location shown on site map ☐ N/A ☐ Vegetation does not impede flow Areal extent_______________ Type_____________ Remarks____ ____
3.	**Erosion** ☐ Location shown on site map ☐ Erosion not evident Areal extent_______________ Depth_____________ Remarks____ ____
4.	**Discharge Structure** ☐ Functioning ☐ N/A Remarks____ ____
VIII. VERTICAL BARRIER WALLS ☐ Applicable x N/A	
1.	**Settlement** ☐ Location shown on site map ☐ Settlement not evident Areal extent_______________ Depth_____________ Remarks____ ____
2.	**Performance Monitoring** Type of monitoring___________________________ ☐ Performance not monitored Frequency_________________________________ ☐ Evidence of breaching Head differential___________________________ Remarks____ ____

IX. GROUNDWATER/SURFACE WATER REMEDIES ☐ Applicable x N/A
A. Groundwater Extraction Wells, Pumps, and Pipelines ☐ Applicable ☐ N/A
1. **Pumps, Wellhead Plumbing, and Electrical** ☐ Good condition ☐ All required wells properly operating ☐ Needs Maintenance ☐ N/A Remarks___
2. **Extraction System Pipelines, Valves, Valve Boxes, and Other Appurtenances** ☐ Good condition ☐ Needs Maintenance Remarks___
3. **Spare Parts and Equipment** ☐ Readily available ☐ Good condition ☐ Requires upgrade ☐ Needs to be provided Remarks___
B. Surface Water Collection Structures, Pumps, and Pipelines ☐ Applicable ☐ N/A
1. **Collection Structures, Pumps, and Electrical** ☐ Good condition ☐ Needs Maintenance Remarks___
2. **Surface Water Collection System Pipelines, Valves, Valve Boxes, and Other Appurtenances** ☐ Good condition ☐ Needs Maintenance Remarks___
3. **Spare Parts and Equipment** ☐ Readily available ☐ Good condition ☐ Requires upgrade ☐ Needs to be provided Remarks___

C. Treatment System ☐ Applicable ☐ N/A	
1.	**Treatment Train** (Check components that apply) ☐ Metals removal ☐ Oil/water separation ☐ Bioremediation ☐ Air stripping ☐ Carbon adsorbers ☐ Filters________________ ☐ Additive (*e.g.*, chelation agent, flocculent)________________ ☐ Others________________ ☐ Good condition ☐ Needs Maintenance ☐ Sampling ports properly marked and functional ☐ Sampling/maintenance log displayed and up to date ☐ Equipment properly identified ☐ Quantity of groundwater treated annually________________ ☐ Quantity of surface water treated annually________________ Remarks________________ ________________
2.	**Electrical Enclosures and Panels** (properly rated and functional) ☐ N/A ☐ Good condition ☐ Needs Maintenance Remarks________________ ________________
3.	**Tanks, Vaults, Storage Vessels** ☐ N/A ☐ Good condition ☐ Proper secondary containment ☐ Needs Maintenance Remarks________________ ________________
4.	**Discharge Structure and Appurtenances** ☐ N/A ☐ Good condition ☐ Needs Maintenance Remarks________________ ________________
5.	**Treatment Building(s)** ☐ N/A ☐ Good condition (esp. roof and doorways) ☐ Needs repair ☐ Chemicals and equipment properly stored Remarks________________ ________________
6.	**Monitoring Wells** (pump and treatment remedy) ☐ Properly secured/locked ☐ Functioning ☐ Routinely sampled ☐ Good condition ☐ All required wells located ☐ Needs Maintenance ☐ N/A Remarks________________ ________________
D. Monitoring Data	
1.	Monitoring Data ☐ Is routinely submitted on time ☐ Is of acceptable quality
2.	Monitoring data suggests: ☐ Groundwater plume is effectively contained ☐ Contaminant concentrations are declining

D. Monitored Natural Attenuation	
1.	**Monitoring Wells** (natural attenuation remedy) □ Properly secured/locked □ Functioning □ Routinely sampled □ Good condition □ All required wells located □ Needs Maintenance □ N/A Remarks____

X. OTHER REMEDIES
If there are remedies applied at the site which are not covered above, attach an inspection sheet describing the physical nature and condition of any facility associated with the remedy. An example would be soil vapor extraction. **Not Applicable**
XI. OVERALL OBSERVATIONS

A.	**Implementation of the Remedy**
	Describe issues and observations relating to whether the remedy is effective and functioning as designed. Begin with a brief statement of what the remedy is to accomplish (i.e., to contain contaminant plume, minimize infiltration and gas emission, etc.). **Former BSVR system to remediate petroleum contamination in soil (now shutdown).**
B.	**Adequacy of O&M**
	Describe issues and observations related to the implementation and scope of O&M procedures. In particular, discuss their relationship to the current and long-term protectiveness of the remedy. **Not Applicable.**
C.	**Early Indicators of Potential Remedy Problems**
	Describe issues and observations such as unexpected changes in the cost or scope of O&M or a high frequency of unscheduled repairs, that suggest that the protectiveness of the remedy may be compromised in the future. **Not Applicable**
D.	**Opportunities for Optimization**
	Describe possible opportunities for optimization in monitoring tasks or the operation of the remedy. **Not Applicable**

PFSA Photo 1

PFSA Photo 2

PFSA Photo 3

SD-4 Site Inspection

Five-Year Review Site Inspection Checklist

I. SITE INFORMATION	
Site name: Storm Drain-4	**Date of inspection: 6/19/13**
Location and Region: Southeastern section of the MMR on the eastern side of the flightline security area	**EPA ID:** MA2570024487
Agency, office, or company leading the five-year review: AFCEC	**Weather/temperature: Sunny, clear, 70s**

Remedy Includes: (Check all that apply)

- ☐ Landfill cover/containment
- ☐ Access controls
- x Institutional controls **(pending)**
- ☐ Groundwater pump and treatment
- ☐ Surface water collection and treatment
- x Other: **Excavation/Ashpalt batching selected at time of ROD, subsequent sampling required, no remedial action.**
- ☐ Monitored natural attenuation
- ☐ Groundwater containment
- ☐ Vertical barrier walls

Attachments: ☐ Inspection team roster attached ☐ Site map attached **See Figure 4-7**

II. INTERVIEWS Not conducted since no ongoing O&M (See Section 3.6)

1. **O&M site manager** ______________________________ ________________________ _____________
   Name Title Date
   Interviewed ☐ at site ☐ at office ☐ by phone Phone no. _______________
   Problems, suggestions; ☐ Report attached ☐ ____
   ____

2. **O&M staff** ______________________________ ________________________ _____________
   Name Title Date
   Interviewed ☐ at site ☐ at office ☐ by phone Phone no. _______________
   Problems, suggestions; ☐ Report attached ____
   ____

3.	**Local regulatory authorities and response agencies** (i.e., State and Tribal offices, emergency response office, police department, office of public health or environmental health, zoning office, recorder of deeds, or other city and county offices, etc.) Fill in all that apply. Agency ______________________________ Contact ______________________________ ___________________ ________ ____________ Name Title Date Phone no. Problems; suggestions; ☐ Report attached ____ ____ Agency ______________________________ Contact ______________________________ ___________________ ________ ____________ Name Title Date Phone no. Problems; suggestions; ☐ Report attached ____ ____ Agency ______________________________ Contact ______________________________ ___________________ ________ ____________ Name Title Date Phone no. Problems; suggestions; ☐ Report attached ____ ____ Agency ______________________________ Contact ______________________________ ___________________ ________ ____________ Name Title Date Phone no. Problems; suggestions; ☐ Report attached ____ ____
4.	**Other interviews** (optional) ☐ Report attached.
none	

III. ON-SITE DOCUMENTS & RECORDS VERIFIED (Check all that apply)

1. **O&M Documents**
☐ O&M manual ☐ Readily available ☐ Up to date x N/A
☐ As-built drawings ☐ Readily available ☐ Up to date x N/A
☐ Maintenance logs ☐ Readily available ☐ Up to date x N/A
Remarks____

2. **Site-Specific Health and Safety Plan** x Readily available x Up to date ☐ N/A
☐ Contingency plan/emergency response plan x Readily available x Up to date ☐ N/A
Remarks____

3. **O&M and OSHA Training Records** ☐ Readily available ☐ Up to date x N/A
Remarks____

4. **Permits and Service Agreements**
☐ Air discharge permit ☐ Readily available ☐ Up to date x N/A
☐ Effluent discharge ☐ Readily available ☐ Up to date x N/A
☐ Waste disposal, POTW ☐ Readily available ☐ Up to date x N/A
☐ Other permits______________________ ☐ Readily available ☐ Up to date x N/A
Remarks____

5. **Gas Generation Records** ☐ Readily available ☐ Up to date x N/A
Remarks____

6. **Settlement Monument Records** ☐ Readily available ☐ Up to date x N/A
Remarks____

7. **Groundwater Monitoring Records** ☐ Readily available ☐ Up to date x N/A
Remarks____

8. **Leachate Extraction Records** ☐ Readily available ☐ Up to date x N/A
Remarks____

9. **Discharge Compliance Records**
☐ Air ☐ Readily available ☐ Up to date x N/A
☐ Water (effluent) ☐ Readily available ☐ Up to date x N/A
Remarks____

10. **Daily Access/Security Logs** ☐ Readily available ☐ Up to date x N/A
Remarks____

IV. O&M COSTS Not Applicable

1. **O&M Organization**

☐ State in-house ☐ Contractor for State
☐ PRP in-house ☐ Contractor for PRP
☐ Federal Facility in-house ☐ Contractor for Federal Facility
☐ Other____________________

2. **O&M Cost Records**

☐ Readily available ☐ Up to date
☐ Funding mechanism/agreement in place
Original O&M cost estimate____________ ☐ Breakdown attached

Total annual cost by year for review period if available

From________ (Date)	To________ (Date)	________ (Total cost)	☐ Breakdown attached
From________ (Date)	To________ (Date)	________ (Total cost)	☐ Breakdown attached
From________ (Date)	To________ (Date)	________ (Total cost)	☐ Breakdown attached
From________ (Date)	To________ (Date)	________ (Total cost)	☐ Breakdown attached
From________ (Date)	To________ (Date)	________ (Total cost)	☐ Breakdown attached

3. **Unanticipated or Unusually High O&M Costs During Review Period**

Describe costs and reasons: ____________________

V. ACCESS AND INSTITUTIONAL CONTROLS ☐ Applicable x N/A

A. Fencing

1. **Fencing damaged** ☐ Location shown on site map ☐ Gates secured ☐ N/A

Remarks____________________

B. Other Access Restrictions

1. **Signs and other security measures** ☐ Location shown on site map ☐ N/A

Remarks____________________

C. Institutional Controls (ICs): Pending

1. **Implementation and enforcement**

Site conditions imply ICs not properly implemented ☐ Yes ☐ No ☐ N/A
Site conditions imply ICs not being fully enforced ☐ Yes ☐ No ☐ N/A

Type of monitoring (*e.g.*, self-reporting, drive by) ______________________
Frequency ______________________
Responsible party/agency ______________________
Contact ______________ ______________ ______ ______
Name Title Date Phone no.

Reporting is up-to-date ☐ Yes ☐ No ☐ N/A
Reports are verified by the lead agency ☐ Yes ☐ No ☐ N/A

Specific requirements in deed or decision documents have been met ☐ Yes ☐ No ☐ N/A
Violations have been reported ☐ Yes ☐ No ☐ N/A
Other problems or suggestions: ☐ Report attached

____
____
____
____

2. **Adequacy** ☐ ICs are adequate ☐ ICs are inadequate ☐ N/A
Remarks______________________
____
____

D. General

1. **Vandalism/trespassing** ☐ Location shown on site map x No vandalism evident
Remarks______________________
____

2. **Land use changes on site** x N/A
Remarks______________________
____

3. **Land use changes off site** x N/A
Remarks______________________
____

VI. GENERAL SITE CONDITIONS

A. Roads x Applicable ☐ N/A

1. **Roads damaged** ☐ Location shown on site map x Roads adequate ☐ N/A
Remarks: **dirt road to access site**

B. Other Site Conditions				
	Remarks: **Heavily vegetated, no evidence of trespassers accessing pond/wetland.**			
	VII. LANDFILL COVERS ☐ Applicable x N/A			
A. Landfill Surface				
1.	**Settlement** (Low spots) Areal extent______________ Remarks______________________________ ______________________________	☐ Location shown on site map Depth____________	☐ Settlement not evident	
2.	**Cracks** Lengths____________ Widths___________ Depths__________ Remarks______________________________ ______________________________	☐ Location shown on site map	☐ Cracking not evident	
3.	**Erosion** Areal extent______________ Remarks______________________________ ______________________________	☐ Location shown on site map Depth____________	☐ Erosion not evident	
4.	**Holes** Areal extent______________ Remarks______________________________ ______________________________	☐ Location shown on site map Depth____________	☐ Holes not evident	
5.	**Vegetative Cover** ☐ Grass ☐ Trees/Shrubs (indicate size and locations on a diagram) Remarks______________________________ ______________________________	☐ Cover properly established	☐ No signs of stress	
6.	**Alternative Cover (armored rock, concrete, etc.)** ☐ N/A Remarks______________________________ ______________________________			
7.	**Bulges** Areal extent______________ Remarks______________________________ ______________________________	☐ Location shown on site map Height____________	☐ Bulges not evident	
8.	**Wet Areas/Water Damage** ☐ Wet areas ☐ Ponding ☐ Seeps ☐ Soft subgrade Remarks______________________________ ______________________________	☐ Wet areas/water damage not evident ☐ Location shown on site map ☐ Location shown on site map ☐ Location shown on site map ☐ Location shown on site map	 Areal extent______________ Areal extent______________ Areal extent______________ Areal extent______________	
9.	**Slope Instability** ☐ Slides Areal extent______________ Remarks______________________________ ______________________________	☐ Location shown on site map	☐ No evidence of slope instability	

B. Benches ☐ Applicable ☐ N/A
(Horizontally constructed mounds of earth placed across a steep landfill side slope to interrupt the slope in order to slow down the velocity of surface runoff and intercept and convey the runoff to a lined channel.)

1. **Flows Bypass Bench** ☐ Location shown on site map ☐ N/A or okay
Remarks____
____

2. **Bench Breached** ☐ Location shown on site map ☐ N/A or okay
Remarks____
____

3. **Bench Overtopped** ☐ Location shown on site map ☐ N/A or okay
Remarks____
____

C. Letdown Channels ☐ Applicable ☐ N/A
(Channel lined with erosion control mats, riprap, grout bags, or gabions that descend down the steep side slope of the cover and will allow the runoff water collected by the benches to move off of the landfill cover without creating erosion gullies.)

1. **Settlement** ☐ Location shown on site map ☐ No evidence of settlement
Areal extent______________ Depth____________
Remarks____
____

2. **Material Degradation** ☐ Location shown on site map ☐ No evidence of degradation
Material type_______________ Areal extent_____________
Remarks____
____

3. **Erosion** ☐ Location shown on site map ☐ No evidence of erosion
Areal extent______________ Depth____________
Remarks____
____

4.	**Undercutting** ☐ Location shown on site map ☐ No evidence of undercutting Areal extent______________ Depth____________ Remarks____ ____	
5.	**Obstructions** Type_____________________ ☐ No obstructions ☐ Location shown on site map Areal extent______________ Size____________ Remarks____ ____	
6.	**Excessive Vegetative Growth** Type____________________ ☐ No evidence of excessive growth ☐ Vegetation in channels does not obstruct flow ☐ Location shown on site map Areal extent______________ Remarks____ ____	
D. Cover Penetrations ☐ Applicable ☐ N/A		
1.	**Gas Vents** ☐ Active ☐ Passive ☐ Properly secured/locked ☐ Functioning ☐ Routinely sampled ☐ Good condition ☐ Evidence of leakage at penetration ☐ Needs Maintenance ☐ N/A Remarks____ ____	
2.	**Gas Monitoring Probes** ☐ Properly secured/locked ☐ Functioning ☐ Routinely sampled ☐ Good condition ☐ Evidence of leakage at penetration ☐ Needs Maintenance ☐ N/A Remarks____ ____	
3.	**Monitoring Wells** (within surface area of landfill) ☐ Properly secured/locked ☐ Functioning ☐ Routinely sampled ☐ Good condition ☐ Evidence of leakage at penetration ☐ Needs Maintenance ☐ N/A Remarks____ ____	
4.	**Leachate Extraction Wells** ☐ Properly secured/locked ☐ Functioning ☐ Routinely sampled ☐ Good condition ☐ Evidence of leakage at penetration ☐ Needs Maintenance ☐ N/A Remarks____ ____	
5.	**Settlement Monuments** ☐ Located ☐ Routinely surveyed ☐ N/A Remarks____ ____	

E. Gas Collection and Treatment ☐ Applicable ☐ N/A	
1.	**Gas Treatment Facilities** ☐ Flaring ☐ Thermal destruction ☐ Collection for reuse ☐ Good condition ☐ Needs Maintenance Remarks____ ____
2.	**Gas Collection Wells, Manifolds and Piping** ☐ Good condition ☐ Needs Maintenance Remarks____ ____
3.	**Gas Monitoring Facilities** (*e.g.*, gas monitoring of adjacent homes or buildings) ☐ Good condition ☐ Needs Maintenance ☐ N/A Remarks____ ____
F. Cover Drainage Layer ☐ Applicable ☐ N/A	
1.	**Outlet Pipes Inspected** ☐ Functioning ☐ N/A Remarks____ ____
2.	**Outlet Rock Inspected** ☐ Functioning ☐ N/A Remarks____ ____
G. Detention/Sedimentation Ponds ☐ Applicable ☐ N/A	
1.	**Siltation** Areal extent______________ Depth____________ ☐ N/A ☐ Siltation not evident Remarks____ ____
2.	**Erosion** Areal extent______________ Depth____________ ☐ Erosion not evident Remarks____ ____
3.	**Outlet Works** ☐ Functioning ☐ N/A Remarks____ ____
4.	**Dam** ☐ Functioning ☐ N/A Remarks____ ____

H. Retaining Walls ☐ Applicable ☐ N/A	
1.	**Deformations** ☐ Location shown on site map ☐ Deformation not evident Horizontal displacement____________ Vertical displacement_______________ Rotational displacement____________ Remarks____ ____
2.	**Degradation** ☐ Location shown on site map ☐ Degradation not evident Remarks____ ____
I. Perimeter Ditches/Off-Site Discharge ☐ Applicable ☐ N/A	
1.	**Siltation** ☐ Location shown on site map ☐ Siltation not evident Areal extent______________ Depth____________ Remarks____ ____
2.	**Vegetative Growth** ☐ Location shown on site map ☐ N/A ☐ Vegetation does not impede flow Areal extent______________ Type____________ Remarks____ ____
3.	**Erosion** ☐ Location shown on site map ☐ Erosion not evident Areal extent______________ Depth____________ Remarks____ ____
4.	**Discharge Structure** ☐ Functioning ☐ N/A Remarks____ ____
VIII. VERTICAL BARRIER WALLS ☐ Applicable x N/A	
1.	**Settlement** ☐ Location shown on site map ☐ Settlement not evident Areal extent______________ Depth____________ Remarks____ ____
2.	**Performance Monitoring** Type of monitoring__________________________ ☐ Performance not monitored Frequency________________________________ ☐ Evidence of breaching Head differential__________________________ Remarks____ ____

IX. GROUNDWATER/SURFACE WATER REMEDIES ☐ Applicable x N/A
A. Groundwater Extraction Wells, Pumps, and Pipelines ☐ Applicable ☐ N/A
1. **Pumps, Wellhead Plumbing, and Electrical** ☐ Good condition ☐ All required wells properly operating ☐ Needs Maintenance ☐ N/A Remarks______________________________
2. **Extraction System Pipelines, Valves, Valve Boxes, and Other Appurtenances** ☐ Good condition ☐ Needs Maintenance Remarks______________________________
3. **Spare Parts and Equipment** ☐ Readily available ☐ Good condition ☐ Requires upgrade ☐ Needs to be provided Remarks______________________________
B. Surface Water Collection Structures, Pumps, and Pipelines ☐ Applicable ☐ N/A
1. **Collection Structures, Pumps, and Electrical** ☐ Good condition ☐ Needs Maintenance Remarks______________________________
2. **Surface Water Collection System Pipelines, Valves, Valve Boxes, and Other Appurtenances** ☐ Good condition ☐ Needs Maintenance Remarks______________________________
3. **Spare Parts and Equipment** ☐ Readily available ☐ Good condition ☐ Requires upgrade ☐ Needs to be provided Remarks______________________________

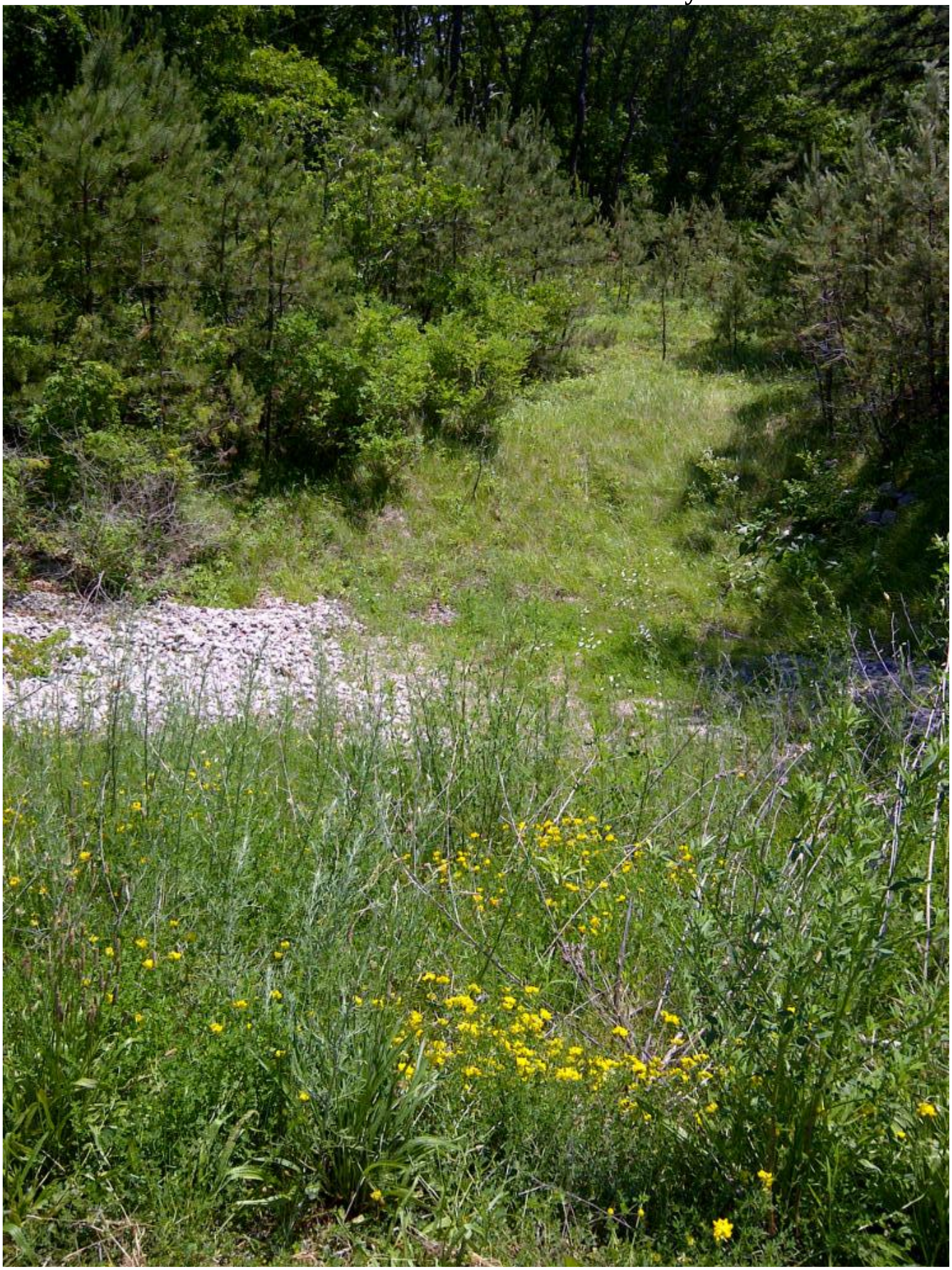
C. **Treatment System** ☐ Applicable ☐ N/A	
1.	**Treatment Train** (Check components that apply) ☐ Metals removal ☐ Oil/water separation ☐ Bioremediation ☐ Air stripping ☐ Carbon adsorbers ☐ Filters____ ☐ Additive (*e.g.*, chelation agent, flocculent)________________________ ☐ Others____ ☐ Good condition ☐ Needs Maintenance ☐ Sampling ports properly marked and functional ☐ Sampling/maintenance log displayed and up to date ☐ Equipment properly identified ☐ Quantity of groundwater treated annually________________ ☐ Quantity of surface water treated annually________________ Remarks____ ____
2.	**Electrical Enclosures and Panels** (properly rated and functional) ☐ N/A ☐ Good condition ☐ Needs Maintenance Remarks____ ____
3.	**Tanks, Vaults, Storage Vessels** ☐ N/A ☐ Good condition ☐ Proper secondary containment ☐ Needs Maintenance Remarks____ ____
4.	**Discharge Structure and Appurtenances** ☐ N/A ☐ Good condition ☐ Needs Maintenance Remarks____ ____
5.	**Treatment Building(s)** ☐ N/A ☐ Good condition (esp. roof and doorways) ☐ Needs repair ☐ Chemicals and equipment properly stored Remarks____ ____
6.	**Monitoring Wells** (pump and treatment remedy) ☐ Properly secured/locked ☐ Functioning ☐ Routinely sampled ☐ Good condition ☐ All required wells located ☐ Needs Maintenance ☐ N/A Remarks____ ____
D. Monitoring Data	
1.	Monitoring Data ☐ Is routinely submitted on time ☐ Is of acceptable quality
2.	Monitoring data suggests: ☐ Groundwater plume is effectively contained ☐ Contaminant concentrations are declining

D. Monitored Natural Attenuation
1. **Monitoring Wells** (natural attenuation remedy) □ Properly secured/locked □ Functioning □ Routinely sampled □ Good condition □ All required wells located □ Needs Maintenance □ N/A Remarks____

X. OTHER REMEDIES
If there are remedies applied at the site which are not covered above, attach an inspection sheet describing the physical nature and condition of any facility associated with the remedy. An example would be soil vapor extraction. **Not Applicable**

XI. OVERALL OBSERVATIONS
A. Implementation of the Remedy
Describe issues and observations relating to whether the remedy is effective and functioning as designed. Begin with a brief statement of what the remedy is to accomplish (i.e., to contain contaminant plume, minimize infiltration and gas emission, etc.). **An ESD will be prepared in 2013 to place a deed restriction on the site**
B. Adequacy of O&M
Describe issues and observations related to the implementation and scope of O&M procedures. In particular, discuss their relationship to the current and long-term protectiveness of the remedy. **Not Applicable**
C. Early Indicators of Potential Remedy Problems
Describe issues and observations such as unexpected changes in the cost or scope of O&M or a high frequency of unscheduled repairs, that suggest that the protectiveness of the remedy may be compromised in the future. **None**
D. Opportunities for Optimization
Describe possible opportunities for optimization in monitoring tasks or the operation of the remedy. **None**

Storm Drain-4 Photo 1: North of Reilly Road



Storm Drain-4 Photo 2: North of Reilly Road

Storm Drain-4 Photo 3: North of Reilly Road

Storm Drain-4 Photo 4: SD-4 Pond/Wetland

Storm Drain-4 Photo 5: SD-4 Pond/Wetland

Storm Drain-4 Photo 6: SD-4 Pond/Wetland

APPENDIX C

Storm Drain-4 (SD-4) Data Analysis to Assess Unrestricted Use Prepared by Portage, Inc. for AFCEC-MMR

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Tables

Appendix C
Storm Drain No. 4 (SD-4) Data Analysis to Assess Unrestricted Use

1.0 Objective

This document has been prepared as part of Five-Year Review activities for the Otis Air National Guard/Camp Edwards Superfund Site. The objective of this data analysis is to determine whether or not site conditions support unlimited use/unrestricted exposure (UU/UE) of surface and subsurface soils at Area of Contamination (AOC) Storm Drain No. 4 (SD-4), which is part of the Otis Air National Guard Installation Restoration Program at the Massachusetts Military Reservation (MMR). The basis for allowing unrestricted use includes the contaminants found at the site; the nature of the contaminant releases; and the remedial action implementation, which included pre-excavation and confirmation sampling and ecological assessments.

2.0 Background

2.1 Site Description

Most of the background information in this evaluation is summarized in the *Remedial Investigation Report Area of Contamination SD-4* (CDM Federal Programs Corporation [CDM] 1996) and *Final 3rd Five-Year Review, 2002-2007* (Air Force Center for Engineering and the Environment [AFCEE] 2008). As shown in Figure 2-1, AOC SD-4 is a wooded drainage basin located in the southeast section of MMR and extends from the flightline security area immediately east of Hangar 124 approximately 3,500 ft south toward Johns Pond.

The drainage basin, which became operational in 1950, received stormwater drainage from storm sewers that lead from Hangars 158, 128, 126 (now demolished), and 124, including the buildings, runways, ramps, and decks that serve four hangars in addition to the former Building 123 pumphouse area. The drainage basin also reportedly received flow from numerous spills and liquids disposal during daily operations at the facilities. In 1968, an oil/water separator (OWS) was constructed in the drainage basin south of Reilly Road.

It was estimated that 0.5 million to 1.4 million gal of petroleum distillate solvents was released to the SD-4 stormwater drainage system from Hangar 158. These solvents, used in daily operations at support shops located in the hangar, were reportedly dumped into hangar deck drains connected to the storm-drain system. From 1955 to 1970, Hangar 128 was used to maintain 18 to 21 aircraft. During that time, known quantities of solvents were released into the storm-drain system. From 1978 to 1988, the hangar was used by the U.S. Coast Guard for aircraft maintenance. Periodic heating of the wing tanks of the aircraft resulted in numerous spills of aviation gasoline (AVGAS) to the hangar deck; a portion of the AVGAS was washed into the storm-drain system. In 1978, a spill of approximately 1,000 gal of AVGAS occurred outside the hangar; it was also flushed into the storm-drain system.

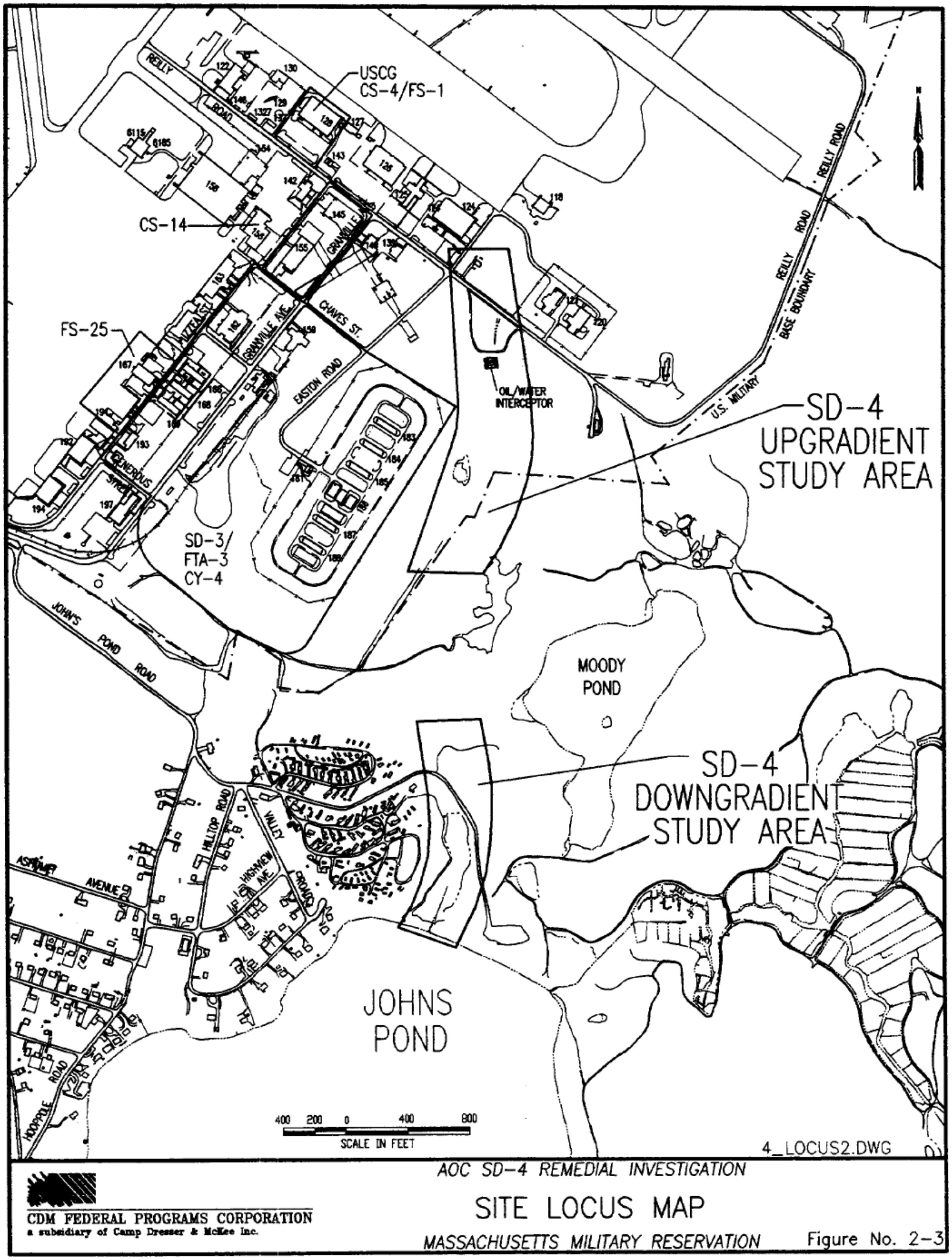


Figure 2-1 AOC SD-4 location (CDM 1996).

2.2 Previous Investigations

2.2.1 Site Investigation

A site investigation (SI) was conducted by ABB Environmental Services, Inc. (ABB-ES) in two phases between 1989 and 1991 (ABB-ES 1993). The SI included a survey of soil gas, sampling of sediment, excavation of test pits, and installation of monitoring wells. A sample of liquid and sediment in the gas trap associated with Building 123 was also collected.

A soil gas survey of the drainage ditch north of Reilly Road in the area that first received discharge from the storm drain did not indicate the presence of target volatile organic compounds (VOCs). SI sediment samples collected in the drainageway were analyzed for target compound list (TCL) organic compounds and TCL inorganics. Analytes detected were the VOC methylene chloride; several semivolatile organic compounds (SVOCs); the pesticides endosulfan I, dieldrin, endosulfan sulfate, gamma-chlordane, dichlorodiphenyldichloroethane; the polychlorinated biphenyls (PCBs) Aroclor-1254 and Aroclor-1260; total petroleum hydrocarbons (TPH); and several inorganics above MMR maximum background levels, including aluminum, arsenic, barium, chromium, cobalt, copper, iron, lead, magnesium, nickel, silver, vanadium, and zinc.

SI samples collected from a test pit excavated at the OWS contained one VOC, chloroform, three SVOCs, and the inorganics lead and zinc. In addition, three test borings completed as monitoring wells (MW-1) or well clusters (MW-2 and MW-3) were installed as part of the SI. VOCs, pesticides, and PCBs were not detected; however, 10 SVOC polycyclic aromatic hydrocarbons (PAHs), the pesticide dieldrin, and the PCB Aroclor-1260 were detected. Inorganics were also detected above MMR maximum background levels, including arsenic, barium, cadmium, chromium, copper, iron, magnesium, manganese, lead, nickel, selenium, silver, vanadium, and zinc.

2.2.2 Remedial Investigation

A remedial investigation (RI) conducted by CDM Federal Programs Corporation included collecting surface soil samples at 14 locations (six of which were for SVOCs only), advancing five test borings, installing four new groundwater monitoring wells, collecting one round of groundwater samples from 11 monitoring wells, sampling sediment at nine locations, and

sampling surface water at seven locations. Other data collected during the hydrogeologic investigation included depths to static groundwater, in situ hydraulic conductivity test data on selected existing and newly installed monitoring wells, and performing grain-size distribution and total organic carbon analysis of sediment samples (CDM 1996).

In the RI, the AOC was differentiated into two study areas, the upgradient and downgradient study areas (see Figure 2-1). Each study area has major site features. The upgradient study area includes the former underground storage tanks (USTs), the head of the drainage system north of Reilly Road, the vicinity of the OWS, and the upgradient pond and associated wetland area. The downgradient study area includes the former cranberry bog. Other significant downgradient site features not directly investigated during the RI include Moody Pond, which is located to the east of the AOC SD-4 drainageway, and Johns Pond Recreational Area (including Johns Pond), which is located at the southern end of the AOC.

Inorganic and organic contamination was detected in all media at AOC SD-4. Three areas where contamination was a concern included the drainage ditch north of Reilly Road; the “upgradient” pond and associated wetlands, which are south of Reilly Road; and groundwater, which contained concentrations of organic and inorganic contaminants.

RI surface soil, sediment, and surface water samples from the streambed leading to or within the downgradient former cranberry bog contained trace to low levels of chlorinated VOCs, SVOCs, pesticides, PCBs, and inorganics. Surface water samples exceeded the federal Ambient Water Quality Criteria for tetrachloroethene. Hydrologic data suggest that the chlorinated VOCs may be due to groundwater discharge to this wetland from source areas north-northwest of this location. Impacts to this area are otherwise not significant.

As part of the RI, a human health preliminary risk assessment (PRA) was performed based on future residential exposure scenarios for surface soil, groundwater, pond sediment, pond surface water, and wetland surface water. Subsurface soil was not evaluated. For surface soil, pond sediment, and wetland surface water, the calculated cancer risks for future residents were within the U.S. Environmental Protection Agency (EPA) target risk range, and the calculated noncancer hazard index (HI) was below 1. For groundwater, the calculated cancer risks for future residents exceeded the EPA target risk range and the calculated noncancer HI of 1. The primary

contributors to the calculated cancer risk were beryllium and arsenic. Both beryllium and arsenic concentrations were below their respective maximum contaminant levels. The primary contributors to the calculated HI were both isomers of trimethylbenzene and manganese. Maximum contaminant levels were not available for these constituents. For pond surface water, the human health PRA calculated cancer risks for future residents exceeded the EPA target risk range and the calculated noncancer HI of 1. The primary contributors to calculated cancer risks were carcinogenic PAHs, dieldrin, and Aroclor 1260. However, the calculated risks were considered conservative because of the following factors: (1) all detected PAHs were assumed to be AOC-related, (2) conservative exposure assumptions were used, and (3) oral slope factors were used to evaluate dermal risks.

The AOC SD-4 PRA evaluated potential ecological risks associated with exposure to contaminated surface soil (0–2 ft below ground surface [bgs]), sediment, and surface water. Evaluations were made for exposure of various ecological receptors to the following media at AOC SD-4: surface soil; pond sediment and pond surface water; and wetlands sediment and wetlands surface water. The ecological risk-based contaminants of concern (COCs) identified for sediments at AOC SD-4 included PAHs, VOCs, pesticides, PCBs, and metals. The ecological risk-based COCs identified for pond surface water at AOC SD-4 included PAHs, pesticides, Aroclor 1260, and metals. The results of the ecological PRA triggered the need for an evaluation of remedial alternatives (i.e., feasibility study).

2.3 Removal Action Planning

2.3.1 Feasibility Study

AOC SD-4 was included as part of the *Final Six Areas of Contamination Source Area Feasibility Study* completed in November 1997 (AFCEE 1997). The following alternatives received a detailed analysis in the feasibility study:

- Alternative 1: No Action
- Alternative 4: Excavation/Asphalt Batching
- Alternative 5: Excavation/Offsite Treatment and Disposal.

2.3.2 Record of Decision

The *Record of Decision for Areas of Contamination FTA-2/LF-2, PFSA/FS-10/FS-11, SD-2/FS-6/ FS-8, SD-3/FTA-3/CY-4, SD-4, and SD-5/FS-5 Source Areas* finalized in September 1998 (AFCEE 1998) was prepared to document the decision to perform remedial actions for several AOCs, including SD-4. The selected remedial alternative for the SD-4 source area was Alternative 4, Excavation/Asphalt Batching.

This alternative provides institutional and engineering controls for areas north of Reilly Road (Detail A) to limit exposure to site-related contaminants in soil and to reduce source-area contaminant concentrations to protective levels. Components of the remedy to address contamination in the drainage ditch north of Reilly Road included pre-excavation sampling to assess the horizontal and vertical distribution of contamination exceeding the TPH soil target cleanup level (STCL) and to identify areas of excavation.

For areas south of Reilly Road (Detail B), this alternative provides for additional sampling and engineering controls to assess the contribution of sediment contaminants to surface water contamination, the potential bioavailability and toxicity of pond sediments, and, if necessary, removal of source area sediments exceeding cleanup criteria (to be developed based on pre-excavation studies). The risk assessment did not identify the need to clean up groundwater at this AOC; consequently, the remedy did not include a management-of-migration component.

The remedial action objectives (RAOs) established for AOC SD-4 are listed as follows:

- Prevent human and ecological exposure to shallow (0–2 ft bgs) drainageway soil and sediment contaminated with TPH exceeding 500 parts per million
- Manage pond sediments to prevent surface water contamination that presents potential risks to human receptors exceeding the EPA cancer risk-management range
- Manage pond sediments to prevent surface water contamination at concentrations exceeding chronic ambient water quality criteria.

Cleanup levels are the site-specific quantitative values that achieve RAOs. For the area designated as SD-4 north of Reilly Road (Detail A), the inside-the-flightline TPH STCL (1,200 mg/kg) was chosen as the cleanup level. No cleanup levels were developed for sediment or surface water when the record of decision (ROD) was finalized.

2.3.3 Explanation of Significant Differences (2013)

A draft explanation of significant differences (ESD) has been prepared that documents the following change to the selected remedy for AOC SD-4 (AFCEC 2013):

- Establishment of current residential cleanup standards for petroleum hydrocarbons (i.e., Massachusetts Contingency Plan [MCP] S-1/SW-1 standards).

This 2013 ESD documents the change in cleanup levels for petroleum hydrocarbons. The Six-AOC ROD petroleum hydrocarbon cleanup level was the industrial risk-based MCP TPH standard of 1,200 mg/kg. The MCP S-1/GW-1 petroleum hydrocarbon standards were used for SD-4 remediation, allowing for unrestricted use after completion of cleanup. Table 2-1 presents the changes in TPH remedial action levels (RALs) for AOC SD-4.

Table 2-1 Revised cleanup levels for SD-4.

COC	ROD STCL (mg/kg)	2013 RAL (mg/kg)/Basis
Aliphatic Hydrocarbons		
C_5–C_8 Aliphatic hydrocarbons	1,200	100 (MCP S-1/GW-1)
C_9–C_{12} Aliphatic hydrocarbons	1,200	1,000 (MCP S-1/GW-1)
C_{13}–C_{18} Aliphatic hydrocarbons	1,200	1,000 (MCP S-1/GW-1)[a]
C_{19}–C_{36} Aliphatic hydrocarbons	1,200	3,000 (MCP S-1/GW-1)
Aromatic Hydrocarbons		
C_9–C_{10} Aromatic hydrocarbons	1,200	100 (MCP S-1/GW-1)
C_{11}–C_{22} Aromatic hydrocarbons	1,200	1,000 (MCP S-1/GW-1)
a. MCP standard is for C_9–C_{18} aliphatic hydrocarbons.		

2.4 Remedial Action Implementation

Two discrete remediation sites were identified at the AOC SD-4 upgradient study area: Detail A (areas north of Reilly Road) and Detail B (areas south of Reilly Road). Implementation activities, conducted by TN and Associates, Inc. (TN&A), included pre-excavation study/sediment and soil sampling and analysis of the stormwater drainage ditch north of Reilly Road and the upgradient upgradient pond/wetland south of Reilly Road.

As for the downgradient study area of AOC SD-4, the RI concluded that impacts from the trace to low levels of chlorinated VOCs, SVOCs, pesticides, PCBs, and inorganics in the surface soil, sediment, and surface water from the streambed leading to or within the downgradient former

cranberry bog are not significant. Therefore, the downgradient study area was not included in the ROD for AOC SD-4.

2.4.1 Detail A (North of Reilly Road)

2.4.1.1 Pre-Excavation Sampling. In August 1999, soil samples were collected, using a hand auger, from three sampling locations (CHSD4-1, CHSD4-2, and CHSD4-3) in the drainage ditch north of Reilly Road (Figure 2-2) to confirm the presence or absence of TPH-contaminated soils that were above 1996 STCLs.

Samples were collected at depths of 0–1 ft bgs and 2.5–3 ft bgs and analyzed for extractable petroleum hydrocarbons/volatile petroleum hydrocarbons (EPH/VPH). Soil samples were also collected from three additional sampling locations (CHSD4-4, CHSD4-5, and CHSD4-6). These samples were collected from the 2.5- to 3-ft bgs interval and were submitted for EPH/VPH analysis. The pre-excavation sampling results are presented in Table 5A of AFCEE (2000a) and in Attachment C-1 of this appendix. The analytical results from Detail A indicated no EPH/VPH exceedances of 1996 STCLs in the drainage ditch (AFCEE 2000a). As a result, no action was required for the drainage ditch north of Reilly Road.

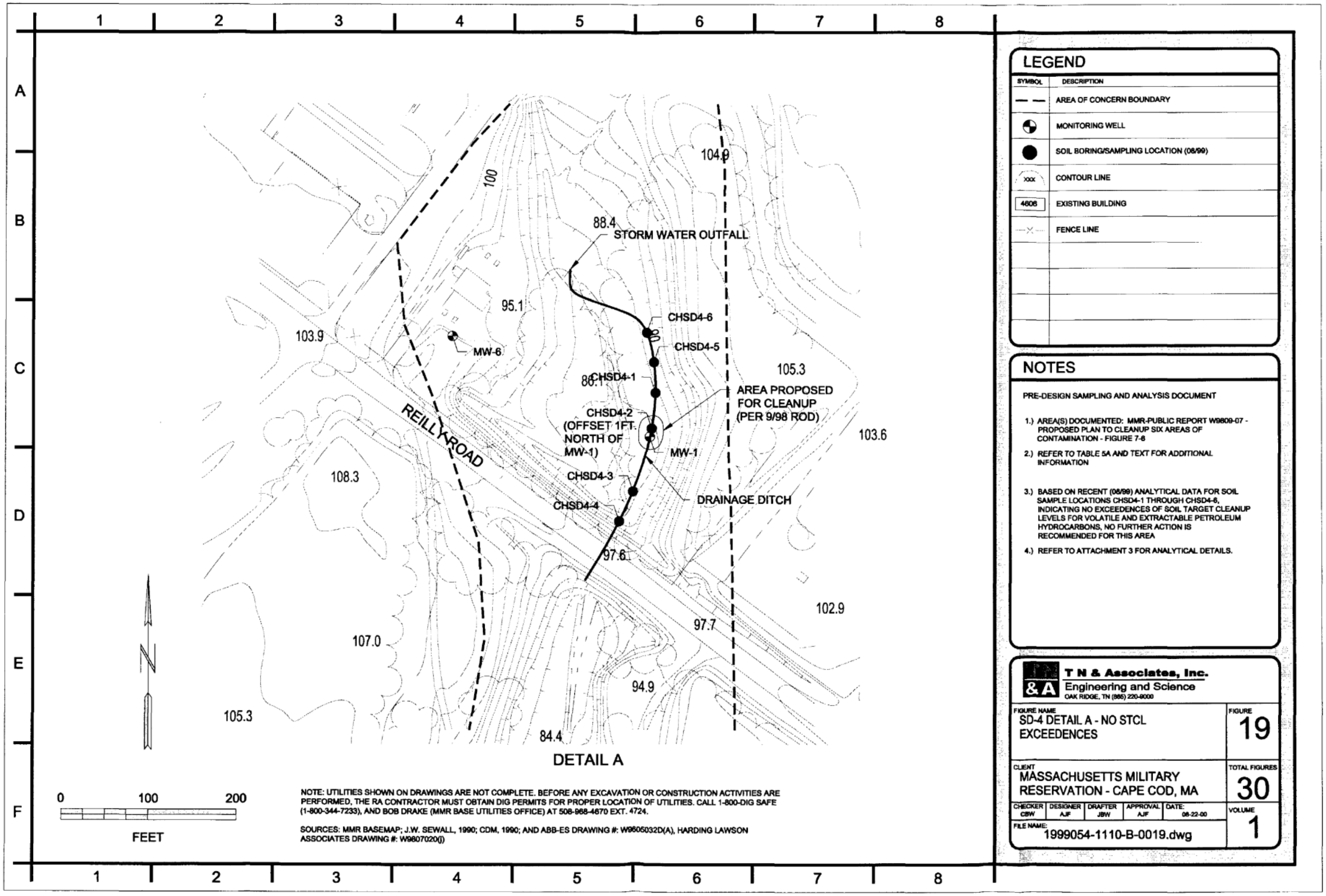


Figure 2-2 AOC SD-4 upgradient study area Detail A pre-excavation soil sample locations (AFCEE 2000a).

2.4.2 Detail B (South of Reilly Road)

2.4.2.1 Pre-Excavation Sampling. Sampling at AOC SD-4 Detail B was conducted concurrently with the drainage ditch sampling at Detail A. Surface-water and sediment samples were collected from three locations (LKSD4-4, LKSD4-5, and LKSD4-6) within the AOC SD-4 Detail B upgradient pond/wetland area in 1999 (Figure 2-3). The three surface-water samples were collected from the pond and analyzed for SVOCs, PCBs, total dissolved (filtered) metals, hardness, and total suspended solids. Field parameter pH was measured and recorded in the field. The three sediment samples were collected from the bottom of the pond at a depth of 0–3 in. bgs and analyzed for metals, acid volatile sulfides/simultaneously extracted metals, and total organic carbons. Data collected at these locations were used in a bioavailability assessment.

The sampling results are presented in Table 5B of AFCEE (2000a) and in Figure 2-3 and Attachment C-2 of this appendix. The sediment analytical data indicated concentrations of metals above reporting limits in the three sediment sampling locations (LKSD4-4, LKSD4-5, and LKSD4-6). Attachment 4 of AFCEE (2000a) compared the sediment analytical results to the MCP S-1 standards and MMR background concentrations for soil (Automated Sciences Group [ASG] 1994) for screening purposes only. At that time, there were no MCP S-1 standards listed for aluminum, copper, iron, magnesium, manganese, and potassium. Although the concentrations of certain metals in sediments exceeded MMR background soil concentrations, only lead and barium exceeded the MCP S-1 standard.

Surface-water results were compared to National Recommended Water Quality Criteria. The criteria maximum concentration for Aroclor 1254 PCBs is 0.014 µg/L. In two surface-water samples, LKSD4-4 (0.064J µg/L) and LKSD4-6 (0.027J µg/L), the concentrations of PCBs exceeded the criteria maximum concentration.

2.4.2.2 Ecological Evaluation (Surface Water and Sediment). Pre-excavation studies at the AOC pond focused on surface water quality, the bioavailability of inorganic contaminants, and evaluation of pond/wetland structure and productivity to assess whether adverse effects are actually occurring and whether sediment remediation was justified (AFCEE 2002). In June 2001, tadpole samples were collected from the SD-4 pond and two reference ponds that are found on the MMR and are similar in size to SD-4 (Opening Pond and Deepbottom Pond); these samples

were then analyzed for metals, pesticides/PCBs, and SVOCs. The risk characterization indicated no or minimal adverse environmental impacts to indicator species at SD-4. It was recommended that the sediments in the SD-4 pond remain undisturbed and that actions to remediate those sediments be discontinued (AFCEE 2002).

2.4.2.3 Ecological Evaluation (Wetland Hydric Soil). Because metals were detected in surface soil adjacent to the pond, additional ecological risk evaluation was planned to determine whether any soil removal was needed. This ecological risk evaluation was documented in the final revised screening level risk assessment (AFCEE 2003a) and the final ecological risk assessment (ERA) addendum (AFCEE 2003b).

Evaluation of potential ecological risks was conducted through analysis of hydric soil samples collected during March 2003 for the purposes of the ERA addendum. The data set was represented by five discrete sampling locations (four onsite and one reference location), as illustrated in Figure 2-4, and included analyses for 23 inorganic compounds, total organic carbon, and grain size. Samples were collected from the 0- to 6-in. sampling horizon. These samples were co-located with a subset of nine samples collected in 2001 and evaluated in the screening-level ERA (SERA). Table 2-1 of AFCEE (2003b) and Attachment C-2 of this report present a sample-by-sample summary of the analytical results of the 2003 sampling program for the ERA addendum as well as the four co-located sampling from the 2001 sampling effort for the SERA.

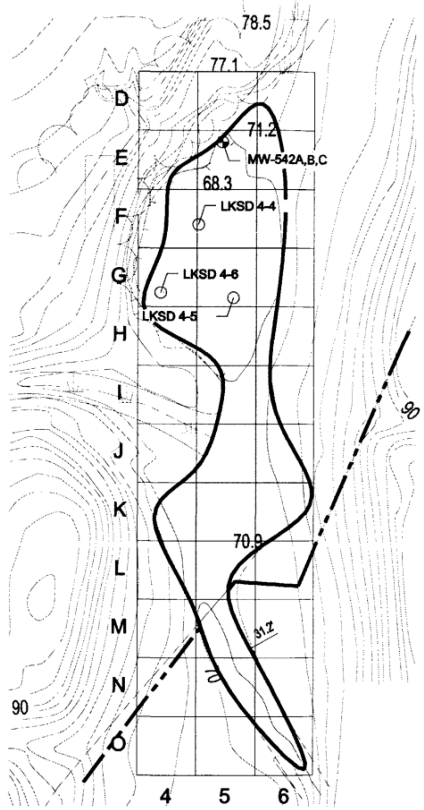
SURFACE WATER (SAMPLED ON 8/19/99)

	REPORTING LIMIT	CMC	CCC	SAMPLE LOCATION @ SURFACE		
ANALYTE (mg/kg)	MG/L	MG/L	MG/L	LKSD4-4	LKSD4-5	LKSD4-6
CADMIUM	0.005	0.0043	0.0022	0.00065 J	ND	ND
VANADIUM	0.050	N/A	N/A	0.0011 J	0.001 J	0.0015 J
ZINC	0.020	0.12	0.12	0.0487	ND	0.0482
SEMI VOLATILE ORGANICS	UG/L	UG/L	UG/L			
BENZO(B)FLUORANTHENE	5	N/A	N/A	ND	ND	2 J
CHRYSENE	5	N/A	N/A	ND	ND	1 J
FLUORANTHENE	5	N/A	N/A	ND	ND	2 J
PYRENE	5	N/A	N/A	ND	ND	2 J
PCBs	UG/L	UG/L	UG/L			
AROCLOR-1254	0.04	0.014	N/A	0.064 J	ND	0.027 J
WATER QUALITY PARAMETERS						
REDOX	MILLIVOLTS	N/A	N/A	225	222	219
CONDUCTIVTY	MOHM/CM	N/A	N/A	0.225	0.223	0.334
PH	pH UNITS	N/A	N/A	5.61	5.28	5.29
TURBIDITY	NTU	N/A	N/A	10	150	38
DISSOLVED OXYGEN	MG/L	N/A	N/A	11.2	12.2	13.7
TOTAL SUSPENDED SOLIDS	MG/L	N/A	N/A	4	ND	35

CLEANUP CRITERIA:

CMC = CRITERIA MAXIMUM CONCENTRATION IS AN ESTIMATE OF THE HIGHEST CONCENTRATION OF A MATERIAL IN SURFACE WATER TO WHICH AN AQUATIC COMMUNITY CAN BE EXPOSED BRIEFLY WITHOUT RESULTING IN AN UNACCEPTABLE EFFECT. (EPA 822-Z-99-001, APRIL 1999)

CCC = CRITERION CONTINUOUS CONCENTRATION IS AN ESTIMATE OF THE HIGHEST CONCENTRATION OF A MATERIAL IN SURFACE WATER TO WHICH AN AQUATIC COMMUNITY CAN BE EXPOSED INDENITELY WITHOUT RESULTING IN AN UNACCEPTABLE EFFECT. (EPA 822-Z-99- 001, APRIL 1999)



DETAIL B

0 100 200

FEET

NOTE: UTILITIES SHOWN ON DRAWINGS ARE NOT COMPLETE. BEFORE ANY EXCAVATION OR CONSTRUCTION ACTIVITIES ARE PERFORMED, THE RA CONTRACTOR MUST OBTAIN DIG PERMITS FOR PROPER LOCATION OF UTILITIES. CALL 1-800-DIG SAFE (1-800-344-7233), AND BOB DRAKE (MMR BASE UTILITIES OFFICE) AT 508-968-4670 EXT. 4724.

SOURCE: MMR BASEMAP

SEDIMENTS (SAMPLED ON 8/19/99)

	REPORTING LIMIT	SAMPLE LOCATION @ 0'-0.25'		
ANALYTE (mg/kg)	MG/KG	LKSD4-4	LKSD4-5	LKSD4-6
TOTAL ORGANIC CARBON	50	1,950	76,000J	200,000
ACID VOLATILE SULFIDE	9.4	ND	523J	420J
ALUMINUM	40	917J	28,600J	17,500J
ARSENIC	2	0.49J	13.3J	10J
BARIUM	40	ND	169	147
CADMIUM	1	.049J	21.9	14.5
CHROMIUM	2	4.1	114	113
COBALT	10	0.22J	8.9J	9.6J
COPPER	5	ND	165	191
IRON	20	1060	26,100	21,800
LEAD	0.6	31.6	963	706
MAGNESIUM	1000	ND	3770	ND
MANGANESE	3	ND	164	136
MERCURY	0.1	ND	0.53	0.52
NICKEL	8	ND	39.7	ND
POTASSIUM	100	40.9J	1,160J	833J
SELENIUM	1	ND	3.7	1.7J
SILVER	2	ND	4.8J	4.3J
THALLIUM	2	ND	4.4J	2.2J
VANADIUM	10	2.8J	85.7	64.1
ZINC	4	ND	700	796

SIMULTANEOUSLY EXTRACTED METALS

	REPORTING LIMIT	SAMPLE LOCATION @ 0'-0.25'		
ANALYTE (mg/kg)	MG/KG	LKSD4-4	LKSD4-5	LKSD4-6
CADMIUM	0.05	0.49	12.9	11.1
COPPER	0.05	2.7	69.8	90.1
LEAD	0.05	30.2	575	522
MERCURY	0.00075	0.01	ND	ND
NICKEL	0.05	3.8	13.9	16.5
ZINC	0.05	12.2	536	510

LEGEND

SYMBOL	DESCRIPTION
	ESTIMATED AREA OF CONTAMINATION (PROPOSED CLEANUP AREA)
	MMR BASE BOUNDARY
	MONITORING WELL
	SURFACE AND SEDIMENT SAMPLING LOCATION (08/99)
XXX	CONTOUR LINE
	GRID BOXES FOR SEDIMENT AND SURFACE WATER SAMPLING

NOTES

1.) AREA(S) DOCUMENTED: MMR-PUBLIC REPORT W9809-07 -PROPOSED PLAN TO CLEANUP SIX AREAS OF CONTAMINATION - FIGURE 7-6
2.) DETAIL B (SEDIMENTS) - PENDING RISK ASSESSMENT AND CLEANUP LEVELS.
APPROXIMATE AREA = 39,550 SQ FT;
DEPTH = 0-2 FT BGS
* TOTAL ESTIMATED EXCAVATION = 2,930 C.Y.
3.) FOR WETLAND DELINATION, SEE U.S. AIR FORCE OFFICE OF THE BASE CIVIL ENGINEER, OTIS AIR NATIONAL GUARD BASE MASS. DRAWING OTS-900-049 (OCT. '90)
4.) OBTAIN PROPER COORDINATION WHEN WORKING OUTSIDE BASE BOUNDARY
5.) REFER TO TABLE 5B, ATTACHMENT 3 AND TEXT FOR ADDITIONAL INFORMATION
6.) ABBREVIATIONS:
J = ESTIMATED VALUE
ND = NOT DETECTED
FT BGS = FEET BELOW GROUND SURFACE
UG/L = MICROGRAMS PER LITER
MG/KG = MILLIGRAMS PER KILAGRAM
MG/L = MILLIGRAMS PER LITER
7.) ESTIMATED AREA OF PROPOSED CLEAN UP/EXCAVATION -FURTHER DELINEATION IS NECESSARY.
8.) ANALYTES DETECTED ABOVE REPORTING LIMITS ARE SHOWN-STCLS FOR SEDIMENTS HAVE NOT BEEN ESTABLISHED FOR SEDIMENTS AT THIS DETAIL AREA.

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OAK RIDGE, TN (865) 220-9000

FIGURE NAME: SD-4 DETAIL B SAMPLE LOCATIONS AND ANALYTICAL RESULTS

FIGURE: 20

CLIENT: MASSACHUSETTS MILITARY RESERVATION - CAPE COD, MA

TOTAL FIGURES: 30

CHECKER	DESIGNER	DRAFTER	APPROVAL	DATE:
CBW	AJF	JBW	AJF	06-22-00

VOLUME: 1

FILE NAME: 1999054-1110-B-0020.dwg

Figure 2-3 AOC SD-4 upgradient study area Detail B pre-excavation sediment sample locations (AFCEE 2000a).

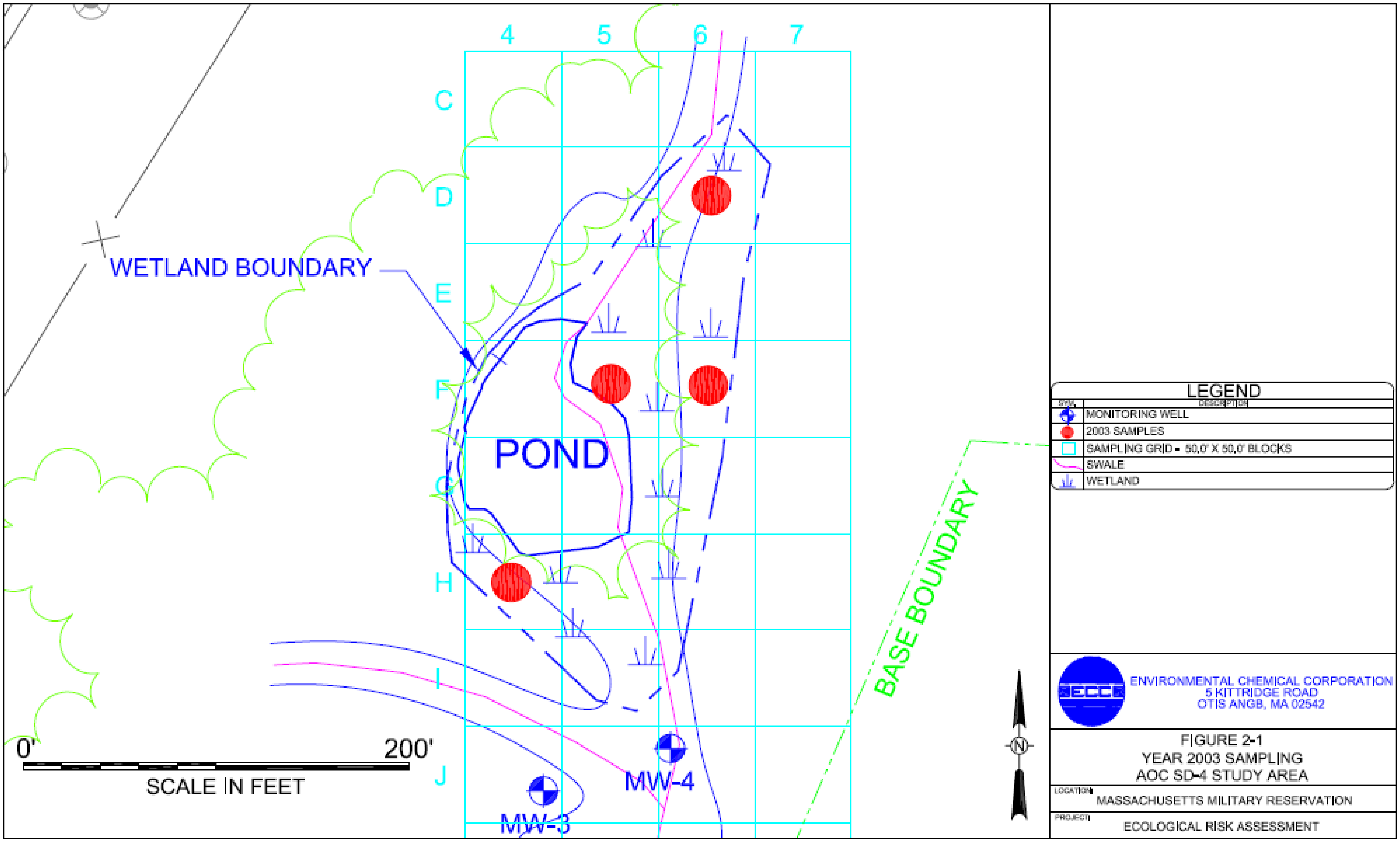

Figure 2-4 AOC SD-4 upgradient study area Detail B hydric soil sample locations (AFCEE 2000a).

Although there are elevated levels of inorganic contaminants of potential concern present in hydric soil in the wetland portion of AOC SD-4, these levels are not likely to have a significant negative impact on the wetland plant and invertebrate communities, and wetland receptors (e.g., plants and terrestrial invertebrates) in AOC SD-4 are not likely to be at risk from exposure to inorganic compounds in hydric soil at this site (AFCEE 2003b). In addition, the SERA (AFCEE 2003a) previously indicated that little to no significant potential risks to vertebrate wildlife are likely from exposure to contaminants of potential concern in SD-4 hydric soil. The conclusions of the post-ROD ERA were that no further action was required for SD-4 hydric soil to be protective of ecological receptors.

3.0 Data Supporting Unrestricted Use

The *Final 3rd Five-Year Review, 2002-2007* (AFCEE 2008) recommended reassessment of AOC SD-4 site data and current MCP soil standards to determine whether or not, based on future residential exposure, an unacceptable risk remains. The unrestricted use assessments for the AOC SD-4 are discussed below.

3.1 Upgradient Study Area

3.1.1 Detail A (North of Reilly Road)

Based on the pre-excavation sampling results, no further action was required for the drainage ditch north of Reilly Road. The results, provided in Attachment C-1 and summarized in Table 3-1 below, support unrestricted use of the surface and subsurface soils at the site. Concentrations of aliphatic and aromatic petroleum hydrocarbon fractions determined in offsite laboratory analyses are below the current MCP S-1/GW-1 standards (MADEP 2012), which are the basis of selection for the 2013 ESD RALs for TPH. EPA residential regional screening levels (RSLs) are not available for petroleum hydrocarbons (EPA 2012).

3.1.2 Detail B (South of Reilly Road)

The results of sediment and hydric soil samples at AOC SD-4 Detail B pond and wetland, respectively, are provided in Attachment C-2 and are summarized in Table 3-2. The focus was on the high concentrations of inorganics (especially lead). However, the ROD did not specify

COCs and cleanup levels for sediment or hydric soil south of Reilly Road. Exceedances of the 2013 ESD RALs, MCP S-1/GW-1 standards, and/or EPA RSLs are summarized as follows:

- Maximum (sample LKSD4-5 for sediment and sample at grid H4 for hydric soil) and average concentrations of arsenic in sediment and hydric soil exceed the EPA RSL (1E-06 excess cancer risk), but they fall between the 1E-05 and 1E-04 excess cancer risk (back-calculated values).
- Maximum (sample LKSD4-5 for sediment and sample at grid F5 for hydric soil) and average concentrations of cadmium in sediment and hydric soil exceed the MCP S-1/GW-1 standard, but they fall below the EPA RSL.
- Maximum (sample LKSD4-5 for sediment and sample at grid F5 for hydric soil) and average concentrations of chromium (total) in sediment and hydric soil are well above the 2013 ESD RAL and MCP S-1/GW-1 standard.
- Maximum (sample LKSD4-5 for sediment and at grid F5 for hydric soil) and average concentrations of lead in sediment and hydric soil are also well above the 2013 ESD RAL, MCP S-1/GW-1 standard, and EPA RSL.
- Maximum (sample LKSD4-5 for sediment and at grid F5 for hydric soil) concentrations of nickel in sediment and hydric soil are above the MCP S-2/GW-1 standard.
- Maximum and average concentrations of thallium in sediment (sample LKSD4-5) are above the 2013 ESD RAL.
- Maximum (sample LKSD4-5) and average concentrations in sediment and maximum concentration (at grid H4) in hydric soil for vanadium exceed the 2013 ESD RALs (ecological risk-based RAL), which is more stringent than the MCP S-1/GW-1 standard and the EPA RLS.

All exceedances are above their respective MMR background surface soil concentrations listed in Table E-1 of ASG (1994).

Table 3-1 Comparison of sampling results, RALs, and current soil screening levels for SD-4 upgradient area, Detail A.

COC	Maximum Pre-Excavation Sampling Results[a]	Sampling Depth (ft)	ROD Cleanup Level	2013 ESD RAL (mg/kg)	MCP S-1/GW-1 Standard	EPA RSL (mg/kg)[c]
Aliphatic Hydrocarbons						
C_5–C_8 Aliphatic hydrocarbons	ND	0–3	1,200	100	100	NA
C_9–C_{12} Aliphatic hydrocarbons	11 J	2.5–3	1,200	1,000	1,000	NA
C_{13}–C_{18} Aliphatic hydrocarbons	ND[d]	0–3	1,200	1,000[d]	1,000[d]	NA
C_{19}–C_{36} Aliphatic hydrocarbons	ND	0–3	1,200	3,000	3,000	NA
Aromatic Hydrocarbons						
C_9–C_{10} Aromatic hydrocarbons	2	2.5–3	1,200	100	100	NA
C_{11}–C_{22} Aromatic hydrocarbons	ND	0–3	1,200	1,000	1,000	NA

a. AFCEE (2000a).

b. MADEP (2012).

c. EPA (2012), lower of HI = 1 or 1E-06 excess cancer risk, total for all pathways.

d. For C_9–C_{18} aliphatic hydrocarbons.

J = Estimated.

Table 3-2 Comparison of sediment and hydric soil sampling results, RALs, and current soil screening levels for SD-4 upgradient area, Detail B.

Contaminant	Average Sampling Result (mg/kg)		Maximum Sampling Result (mg/kg)		Sampling Depth (ft)		ROD Cleanup Level (mg/kg)	2013 ESD RALs (mg/kg)	MCP S-1/GW-1 Standard (mg/kg)[c]	EPA RSL (mg/kg)[d]
	In Sediment[a]	In Hydric Soil[b]	In Sediment[a]	In Hydric Soil[b]	In Sediment	In Hydric Soil				
Aluminum	15,672.33	10,983.13	28,600.00	18,900.00	0–0.25	0–0.5	NA	NA	NA	77,000
Antimony	–	0.99	–	2.30	0–0.25	0–0.5	NA	NA	20	31
Arsenic	**7.93**	**5.90**	**13.30**	**7.10**	0–0.25	0–0.5	NA	NA	20	0.39 (3.9) (39)[e]
Barium	118.67	84.28	169.00	117.00	0–0.25	0–0.5	NA	NA	1,000	15,000
Beryllium	–	0.52	–	0.75	0–0.25	0–0.5	NA	NA	100	160
Cadmium	**12.30**	**5.90**	**21.90**	**17.60**	0–0.25	0–0.5	NA	NA	2	70
Calcium	–	1,692.60	–	2,950.00	0–0.25	0–0.5	NA	NA	NA	NA
Chromium (total)	**77.03**	**68.48**	**114.00**	**99.10**	0–0.25	0–0.5	NA	19	30	NA
Cobalt	6.24	4.37	9.60	6.60	0–0.25	0–0.5	NA	NA	NA	23
Copper	120.33	57.32	191.00	120.00	0–0.25	0–0.5	NA	61	NA	3,100
Iron	16,320.00	13,661.00	26,100.00	17,800.00	0–0.25	0–0.5	NA	NA	NA	55,000
Lead	**567.53**	**477.93**	**963.00**	**855.00**	0–0.25	0–0.5	NA	99	300	400
Magnesium	1,923.33	1,955.80	3,770.00	2,900.00	0–0.25	0–0.5	NA	NA	NA	NA
Manganese	101.00	149.00	164.00	271.00	0–0.25	0–0.5	NA	NA	NA	1,800
Mercury	0.38	0.31	0.53	0.58	0–0.25	0–0.5	NA	10	20	10
Nickel	18.57	18.08	**39.70**	**27.60**	0–0.25	0–0.5	NA	NA	20	NA
Potassium	677.97	601.90	1,160.00	847.00	0–0.25	0–0.5	NA	NA	NA	NA
Selenium	2.13	1.48	3.70	2.20	0–0.25	0–0.5	NA	NA	400	390
Silver	3.70	3.31	4.80	5.00	0–0.25	0–0.5	NA	NA	100	390
Sodium	–	158.11	–	375.00	0–0.25	0–0.5	NA	NA	NA	NA

Contaminant	Average Sampling Result (mg/kg)		Maximum Sampling Result (mg/kg)		Sampling Depth (ft)		ROD Cleanup	2013 ESD RALs	MCP S-1/GW-1	EPA RSL (mg/kg)[d]
Thallium	**2.87**	–	**4.40**	–	0–0.25	0–0.5	NA	NA	8	0.78[f]
Vanadium	**50.80**	31.74	**85.70**	**53.80**	0–0.25	0–0.5	NA	47	600	390
Zinc	500.00	175.06	796.00	370.00	0–0.25	0–0.5	NA	68	2,500	23,000

a. AFCEE (2000a).

b. AFCEE (2003b).

c. MADEP (2012).

d. EPA (2012), lower of HI = 1 or 1E-06 excess cancer risk, total for all pathways.

e. EPA (2012), carcinogenic target risk of 1E-05 (3.9 mg/kg) and 1E-04 (39 mg/kg).

f. EPA (2012), RSL for thallium soluble salts.

NA = Not available or not applicable.

– = not analyzed.

Bold = Exceeds one or more cleanup standards.

The post-ROD ecological evaluation of the pond sediment (AFCEE 2002) and the SERA (AFCEE 2003a) and ERA addendum (AFCEE 2003b) of the wetland hydric soil recommended the sediments and hydric soil remain undisturbed and no further action was required to be protective of ecological receptors. The fact that there are still contaminants left in place does not support unrestricted use of the upgradient pond and wetland at the AOC SD-4 upgradient study area, Detail B.

3.1.3 Groundwater

Project note SD-4PN02032009 (AFCEE 2009) presents groundwater sampling performed at AOC SD-4 to determine whether or not residual concentrations of isomers of trimethylbenzene (TMB) remain in groundwater immediately downgradient from the former location of Building 123 pumphouse and associated USTs, which are within the AOC SD-4 upgradient study area. The project note was developed to address isomers of TMB detected in MW-6 (179 µg/L) during the RI site characterization activities (CDM 1996). As shown in Figure 3-1, this well was located near the former Building 123 pumphouse and associated UST. The well has since been abandoned. TMB was not detected in any other wells.

Because no defined plume underlies AOC SD-4, it is necessary to discuss the issue of TMB in the groundwater in this unrestricted use analysis. Sampling was conducted per SD-4PN02032009 at the former location of MW-6 (Figure 3-1) on March 6, 2009. Results, included in Attachment C-3 of this report, indicate that 1,2,4-TMB and 1,3,5-TMB are detected at 2.4 µg/L and 0.24 µg/L, respectively. TMB is not a COC for AOC SD-4, and no MCLs have been established for this compound. TMB, however, is being monitored at another site at MMR, Fuel Spill No. 13 (FS-13). For FS-13, a risk-based cleanup goal of 17 ppb (17 µg/L) was calculated based on an HI of 1 (AFCEE 2000b). Therefore, the detections of 1,2,4-TMB (2.4 µg/L) and 1,3,5-TMB (0.24 µg/L) are below the cleanup goal set for FS-13.

3.2 Downgradient Study Area

The ROD and post-ROD activities did not include the AOC SD-4 downgradient study area, which covers the former cranberry bog. Results from the RI, included in Attachment C-4 of this

appendix and summarized in Table 3-3, are used for this unrestricted use analysis. Soil and sediment sample locations are shown in Figures 3-2 and 3-3, respectively.

Concentrations of contaminants listed in Table 3-3, with the exception of arsenic, are below the current MCP S-1/GW-1 standards, 2013 ESD RALs, and EPA RSLs. The maximum concentration of arsenic exceeds the EPA RSL (1E-06 excess cancer risk) but falls between the 1E-5 and 1E-04 excess cancer risk (back-calculated values).

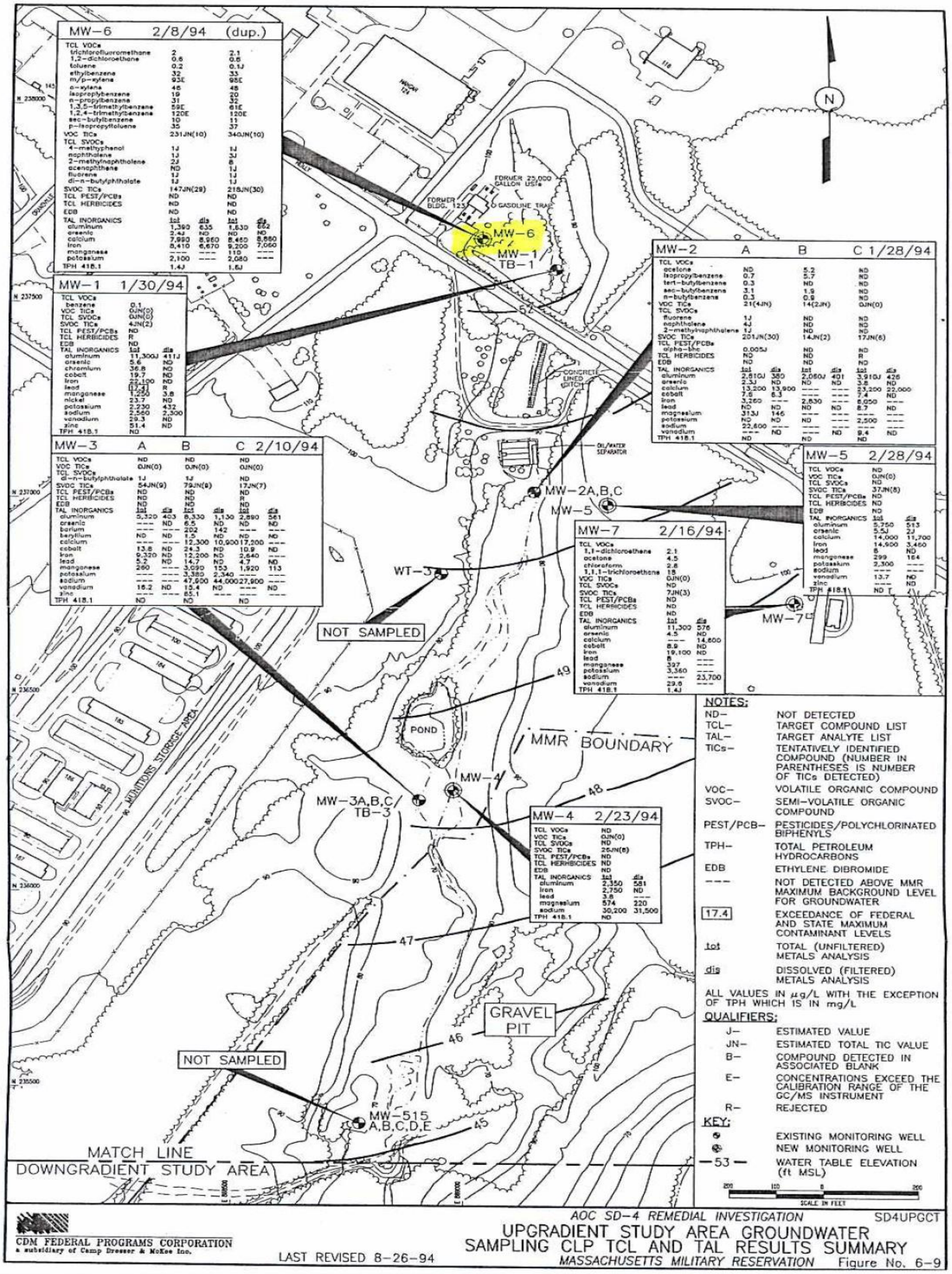

Figure 3-1 AOC SD-4 upgradient study area groundwater sample locations (CDM 1996).

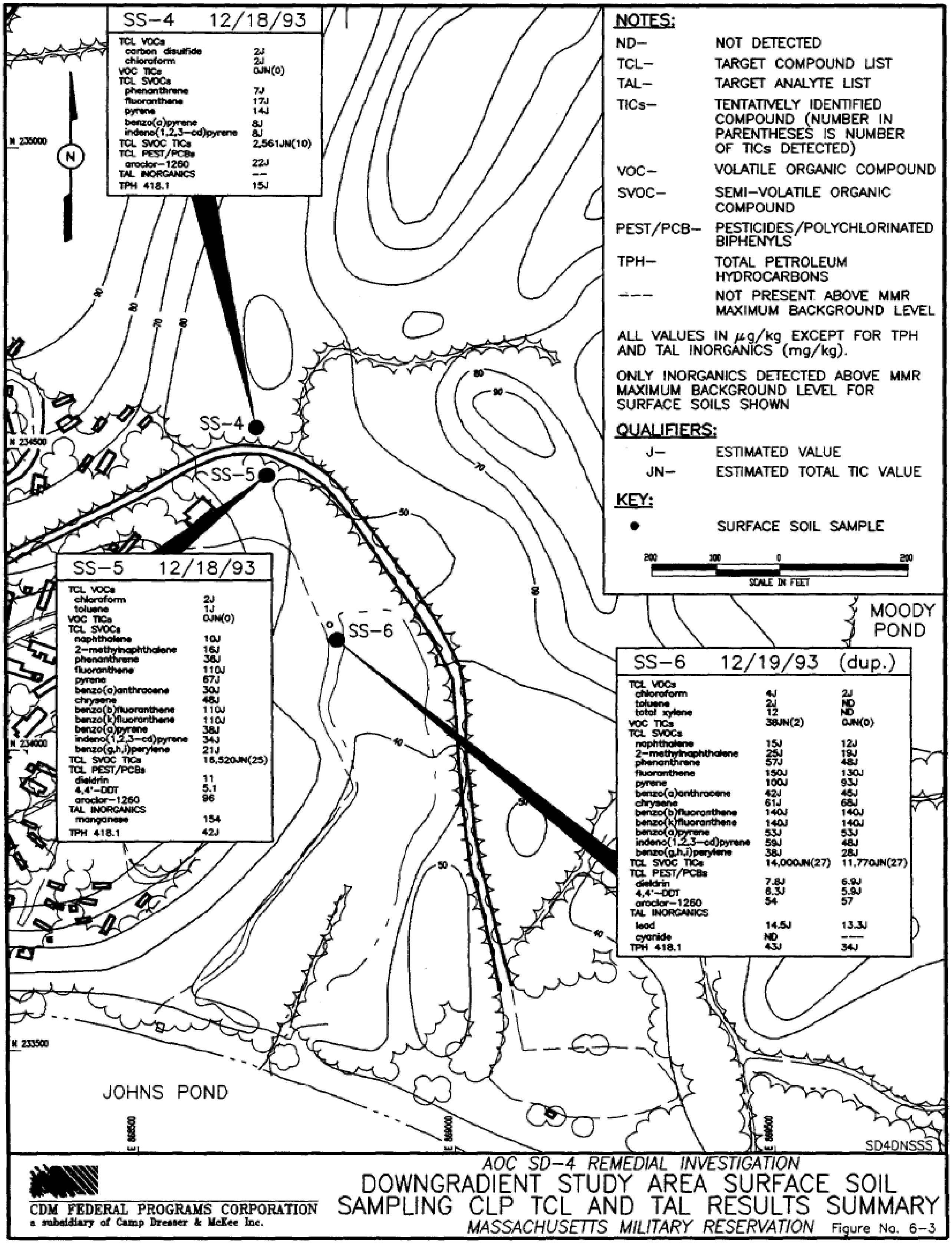

Figure 3-2 AOC SD-4 downgradient study area soil sample locations (CDM 1996).

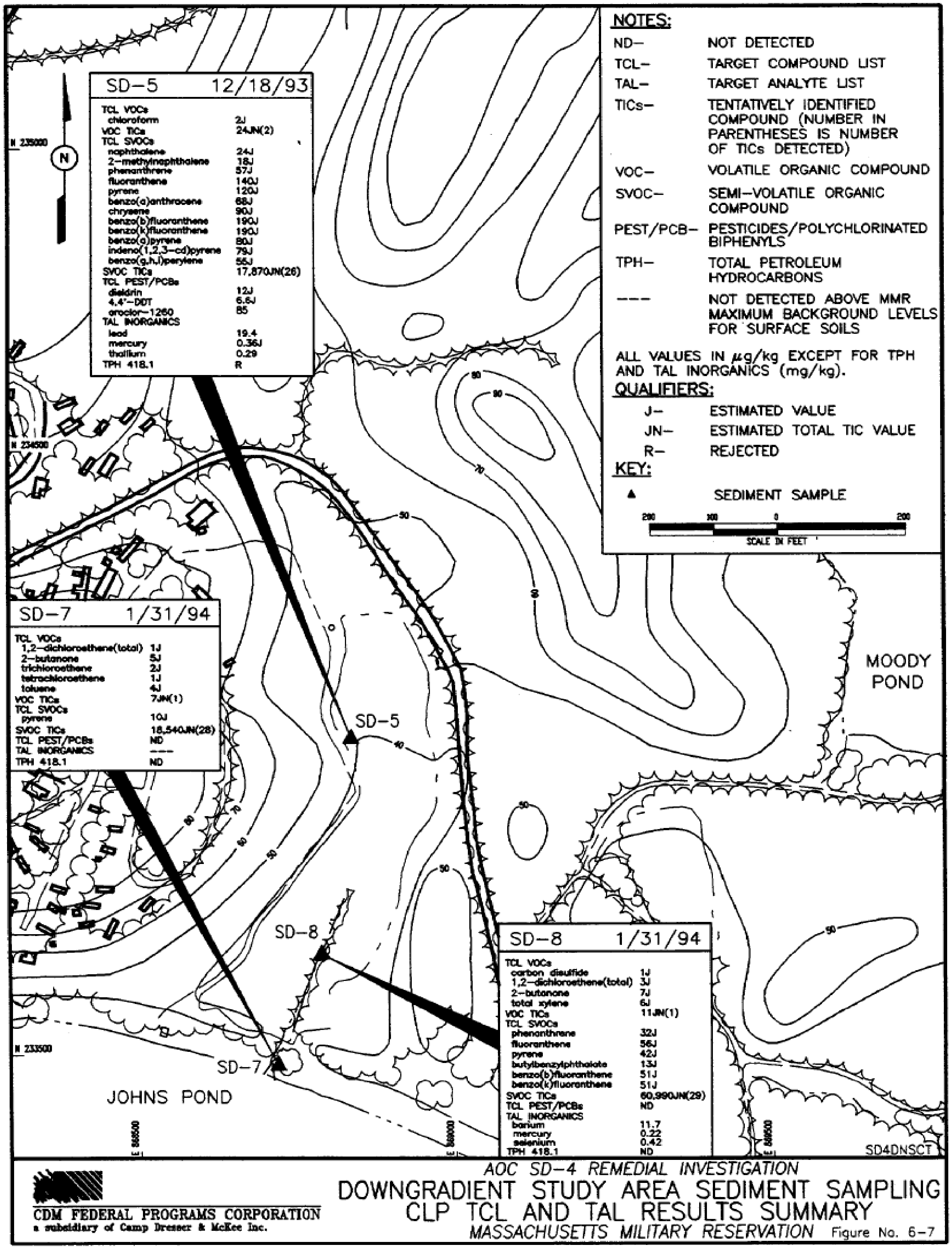

Figure 3-3 AOC SD-4 downgradient study area sediment sample locations (CDM 1996).

Table 3-3 Comparison of sampling results, RALs, and current soil screening levels for SD-4 downgradient area.

Contaminants	Maximum Sampling Results[a]	Sampling Depth (ft)	ROD Cleanup Level	2013 ESD RAL (mg/kg)	MCP S-1/GW-1 Standard	EPA RSL (mg/kg)[c]
Inorganics						
Aluminum	2,520	0–2	NA	NA	NA	77,000
Antimony	ND	0–2	NA	NA	20	31
Arsenic	**1.7**	0–2	NA	NA	20	0.39 (3.9) (39)[d]
Barium	7.9	0–2	NA	NA	1,000	15,000
Beryllium	ND	0–2	NA	NA	100	160
Cadmium	0.53	0–2	NA	NA	2	70
Calcium	306	0–2	NA	NA	NA	NA
Chromium (total)	5.1	0–2	NA	19	30	NA
Cobalt	1.2	0–2	NA	NA	NA	23
Copper	3.9	0–2	NA	61	NA	3,100
Iron	4,650	0–2	NA	NA	NA	55,000
Lead	14.5	0–2	NA	99	300	400
Magnesium	410	0–2	NA	NA	NA	NA
Manganese	154	0–2	NA	NA	NA	1,800
Mercury	ND	0–2	NA	10	20	10
Nickel	2.1	0–2	NA	NA	20	NA
Potassium	193	0–2	NA	NA	NA	NA
Selenium	ND	0–2	NA	NA	400	390
Silver	ND	0–2	NA	NA	100	390

Table 3-3 (continued).

Contaminants	Maximum Sampling Results[a]	Sampling Depth (ft)	ROD Cleanup Level	2013 ESD RAL (mg/kg)	MCP S-1/GW-1 Standard	EPA RSL (mg/kg)[c]
Inorganics						
Sodium	ND	0–2	NA	NA	NA	NA
Thallium	ND	0–2	NA	NA	8	0.78[e]
Vanadium	10.1	0–2	NA	47	600	390
Zinc	14.2	0–2	NA	68	2,500	23,000
TPH	43	0–2	NA	1000	1000	NA
Dieldrin	0.011	0–2	NA	0.05	0.05	0.03
Chrysene	0.068	0–2	NA	0.625	70	15
Fluoranthene	0.15	0–2	NA	7.81	1,000	2,300
Pyrene	0.1	0–2	NA	4.69	1,000	1,700
Phenanthrene	0.057	0–2	NA	0.625	10	NA

a. AFCEE (2000a)

b. MADEP (2012).

c. EPA (2012), lower of HI = 1 or 1E-06 excess cancer risk, total for all pathways.

d. EPA (2012), carcinogenic target risk of 1E-05 (3.9 mg/kg) and 1E-04 (39 mg/kg).

e. EPA (2012), RSL for thallium soluble salts.

NA = Not available.

3.3 Summary

The *Final 3rd Five-Year Review, 2002-2007* (AFCEE 2008) recommended reassessment of AOC SD-4 site data and current standards to determine whether or not, based on future residential exposure, an unacceptable risk remains and preparing an ESD to document changes to the remedy documented in the ROD. With the exception of the pond and wetland at the AOC SD-4 upgradient study area Detail B, the pre-excavation sampling results and ecological assessments results all support unrestricted use of AOC SD-4 relative to the 2013 ESD RALs and the current

MCP S-1/GW-1 standards and EPA RSLs. As discussed in Section 3.1.2, the inorganic contaminants (i.e., arsenic, cadmium, chromium [total], lead, nickel, thallium, and vanadium) left in place do not support unrestricted use of the upgradient pond and wetland at the AOC SD-4 upgradient study area, Detail B. Subsequent land use controls are required specifically for the upgradient pond and wetland at Detail B (south of Reilly Road).

The Five-Year Review also stated that groundwater needs to be re-evaluated to determine whether or not additional RAO and subsequent land use controls are required for the SD-4 area. The 2009 TMB results in groundwater support unrestricted use of groundwater. No groundwater restrictions/control requirements on groundwater are required.

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Attachment C-1

Pre-Excavation Sampling Results for AOC SD-4

Upgradient Study Area, Detail A

Table 5A

SOIL SAMPLE ANALYTICAL RESULTS FOR CONTAMINANTS OF CONCERN AT AOC SD-4

(Drainage Ditch North of Reilly Road)

Analyte	Reporting Limit	STCL	CHSD4-1 8/18/99 0-0.5	CHSD4-1 8/18/99 2.5-3	CHSD4-2 8/18/99 0-0.5	CHSD4-2 8/18/99 2.5-3	CHSD4-3 8/19/99 0-0.5	CHSD4-3 8/19/99 2.5-3
Extractable Petroleum Hydrocarbons	**(MG/KG)**	**(MG/KG)**						
C9-C18 ALIPHATICS	3.1	1200	ND	ND	ND	ND	ND	ND
C11-C22 AROMATICS	8.8	1200	ND	ND	ND	ND	ND	ND
C19-C36 ALIPHATICS	4.1	1200	ND	ND	ND	ND	ND	ND
Volatile Petroleum Hydrocarbons	**(MG/KG)**	**(MG/KG)**						
C5-C8 ALIPHATICS	2	1200	ND	ND	ND	ND	ND	ND
C9-C10 AROMATICS	0.5	1200	ND	ND	ND	ND	ND	ND
C9-C12 ALIPHATICS	0.5	1200	ND	ND	ND	0.6	0.810 J	ND

Analyte	Reporting Limit	STCL	CHSD4-4 8/19/99 2.5-3	CHSD4-5 8/19/99 2.5-3	CHSD4-6 8/19/99 2.5-3
Extractable Petroleum Hydrocarbons	**(MG/KG)**	**(MG/KG)**			
C9-C18 ALIPHATICS	3.1	1200	ND	ND	ND
C11-C22 AROMATICS	8.8	1200	ND	ND	ND
C19-C36 ALIPHATICS	4.1	1200	ND	ND	ND
Volatile Petroleum Hydrocarbons	**(MG/KG)**	**(MG/KG)**			
C5-C8 ALIPHATICS	2	1200	ND	ND	ND
C9-C10 AROMATICS	0.5	1200	2	1.2	ND
C9-C12 ALIPHATICS	0.5	1200	11 J	5.8 J	ND

Notes:
ND = Not Detected
J = Estimated Value
Bold = Concentration Exceeding Applicable STCL.
STCL = 1996 Soil Target Cleanup Level within the Flightline.

Attachment C-2
Pre-excavation and Post-ROD Sampling Results for
AOC SD-4 Upgradient Study Area, Detail B

Table 5B
SEDIMENT AND SURFACE WATER SAMPLES ANALYTICAL RESULTS FOR AOC SD-4
(Upgradient Pond South of Reilly Road)

Sediments

Analyte	Reporting Limit	LKSD4-4 8/19/99	LKSD4-5 8/19/99	LKSD4-6 8/19/99
Metals	**(MG/KG)**	0-0.25	0-0.25	0-0.25
ALUMINUM	40	917 J	28600 J	17500 J
ARSENIC	2	0.49 J	13.3 J	10 J
BARIUM	40	ND	169	147
CADMIUM	1	0.49 J	21.9	14.5
CHROMIUM	2	4.1	114	113
COBALT	10	0.22 J	8.9 J	9.6 J
COPPER	5	ND	165	191
IRON	20	1060	26100	21800
LEAD	0.6	31.6	963	708
MAGNESIUM	1000	ND	3770	ND
MANGANESE	3	ND	164	136
MERCURY	0.1	ND	0.53	0.52
NICKEL	8	ND	39.7	ND
POTASSIUM	100	40.9 J	1160 J	833 J
SELENIUM	1	ND	3.7	1.7 J
SILVER	2	ND	4.8 J	4.3 J
THALLIUM	2	ND	4.4 J	2.2 J
VANADIUM	10	2.6 J	85.7	64.1
ZINC	4	ND	700	796
Simultaneously Extracted Metals	**(MG/KG)**			
CADMIUM	0.05	0.49	12.9	11.1
COPPER	0.05	2.7	69.8	90.1
LEAD	0.05	30.2	575	522
MERCURY	0.00075	0.01	ND	ND
NICKEL	0.05	3.8	13.9	16.5
ZINC	0.05	12.2	536	510
Wet Chemistry	**(MG/KG)**			
ACID VOLATILE SULFIDE	9.4	ND	523 J	420 J
TOTAL ORGANIC CARBON	50	1950	76000 J	200000

Notes:
ND = Not Detected
J = Estimated Value

Site-specific cleanup levels for sediments will be proposed based upon a forthcoming risk assessment determination. The proposed cleanup levels will be submitted for approval to AFCEE, USEPA, and MADEP in order to determine if remedial action is necessary at this site.

Table 5B
SEDIMENT AND SURFACE WATER SAMPLES ANALYTICAL RESULTS FOR AOC SD-4
(Upgradient Pond South of Reilly Road)

Surface Water

Analyte	Reporting Limit	CMC	CCC	LKSD4-4 8/19/99 0-0	LKSD4-5 8/19/99 0-0	LKSD4-6 8/19/99 0-0
Metals	**(MG/L)**	**(MG/L)**	**(MG/L)**			
CADMIUM	0.005	0.0043	0.0022	0.00065 J	ND	ND
VANADIUM	0.05	N/A	N/A	0.0011 J	0.001 J	0.0015 J
ZINC	0.02	0.12	0.12	0.0487	ND	0.0482
Semi Volatile Organics	**(UG/L)**	**(UG/L)**	**(UG/L)**			
BENZO(B)FLUORANTHENE	5	N/A	N/A	ND	ND	2 J
CHRYSENE	5	N/A	N/A	ND	ND	1 J
FLUORANTHENE	5	N/A	N/A	ND	ND	2 J
PYRENE	5	N/A	N/A	ND	ND	2 J
PCBs	**(UG/L)**	**(UG/L)**	**(UG/L)**			
AROCLOR-1254	0.04	0.014	N/A	0.064 J	ND	0.027 J
Water Quality Parameters						
REDOX	**(MILLIVOLTS)**	N/A	N/A	225	222	219
CONDUCTIVITY	**(MOHM/CM)**	N/A	N/A	0.225	0.223	0.334
PH	**(pH UNITS)**	N/A	N/A	5.61	5.28	5.29
TURBIDITY	**(NTU)**	N/A	N/A	10	150	38
DISSOLVED OXYGEN	**(MG/L)**	N/A	N/A	11.2	12.2	13.7
TOTAL SUSPENDED SOLIDS	**(MG/L)**	N/A	N/A	4	ND	35

Notes:

CMC = Criteria Maximum Concentration is an estimate of the highest concentration of a material in surface water to which an aquatic community can be exposed briefly without resulting in an unacceptable effect. (EPA 822-Z-99-001, April 1999)

CCC = Criterion Continuous Concentration is an estimate of the highest concentration of a material in surface water to which an aquatic community can be exposed indefinitely without resulting in an unacceptable effect. (EPA 822-Z-99-001, April 1999)

ND = Not Detected

J = Estimated Value

TABLE 2-1
SAMPLE-BY-SAMPLE SUMMARY OF 2001 AND 2003 HYDRIC SOIL DATA
ECOLOGICAL RISK ASSESSMENT ADDENDUM
AOC SD-4 STUDY AREA
MASSACHUSETTS MILITARY RESERVATION

	ANALYTICAL RESULTS (mg/kg)								
Sampling Grid	**D6**	**D6**	**F5**	**F5**	**F6**	**F6**	**H4**	**H4**	**Site Specific Background**
Sampling Year	**2001**	**2003**	**2001**	**2003**	**2001**	**2003**	**2001**	**2003**	**2003**
Aluminum	4395	9850	17500	18900	4670	6520	9030	17000	3320
Antimony	NA	0.57 J	2.3 J	0.95 J	NA	0.295 J	NA	0.84 J	0.32 U
Arsenic	NA	6.5	5.6 J	5.2	NA	5.1	NA	7.1	0.87 J
Barium	NA	73.5	75.8	104	NA	51.1	NA	117	18.2
Beryllium	NA	0.40 J	0.57 J	0.75 J	NA	0.25 J	NA	0.61 J	0.13 J
Cadmium	3.5	5.4	17.6	4.4	2.5	4.9	3.3	5.6	0.05 U
Calcium	NA	1190	758	1970	NA	1595	NA	2950	509
Chromium	NA	57.2	84.1	99.1 J	NA	20.5	NA	81.5	4.3
Cobalt	NA	3.4	4.4 J	5.1	NA	2.35	NA	6.6	0.16 U
Copper	20.7	62.6	96.6	120	9.6	24.55	32.5	92	5.3
Iron	NA	11500	12800	17800	NA	8605	NA	17600	1870
Lead	294.5	541	855	708	93.95	268	315	748	21.9
Magnesium	NA	1370	2210	2900	NA	789	NA	2510	139
Manganese	NA	119	81	111	NA	163	NA	271	19
Mercury	NA	0.25	0.19	0.58 J	NA	0.13	NA	0.41	0.079
Nickel	NA	13.4	18.7	27.6	NA	8.4	NA	22.3	3.1
Potassium	NA	387 J	847	760 J	NA	293.5 J	NA	722 J	158 J
Selenium	NA	1.3	0.86 J	2.2	NA	1.15	NA	1.9	0.8 J
Silver	NA	2.9	5	4.3	NA	0.835	NA	3.5	0.14 U
Sodium	NA	73 U	154	375	NA	97.25 J	NA	91.3 U	222 J
Vanadium	11.45	28.6	48.2	53.8	12.95	24.4	21.8	52.7	11.9
Zinc	53.95	148	283	370	49.75	105.15	89.6	301	14.3

NA - Not Analyzed.
J - Estimated Value.
U - Not detected (detection limit is presented).

Attachment C-3
Groundwater Sampling Results for AOC SD-4 Upgradient Study Area

Location	Sample Date	Test	Sample Depth (ft bgs)	Matrix	Analyte	Analyte Result (µg/L)
29BH0006	3/6/2009	SW8260B	56.5	WA	1,1,1-TRICHLOROETHANE	ND
29BH0006	3/6/2009	SW8260B	56.5	WA	1,1,2,2-TETRACHLOROETHANE	ND
29BH0006	3/6/2009	SW8260B	56.5	WA	1,1,2-TRICHLOROETHANE	ND
29BH0006	3/6/2009	SW8260B	56.5	WA	1,1-DICHLOROETHANE	ND
29BH0006	3/6/2009	SW8260B	56.5	WA	1,1-DICHLOROETHENE	ND
29BH0006	3/6/2009	SW8260B	56.5	WA	1,2,4-TRICHLOROBENZENE	ND
29BH0006	3/6/2009	SW8260B	56.5	WA	1,2,4-TRIMETHYLBENZENE	2.4
29BH0006	3/6/2009	SW8260B	56.5	WA	1,2-DIBROMO-3-CHLOROPROPANE	ND
29BH0006	3/6/2009	SW8260B	56.5	WA	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	ND
29BH0006	3/6/2009	SW8260B	56.5	WA	1,2-DICHLOROBENZENE	ND
29BH0006	3/6/2009	SW8260B	56.5	WA	1,2-DICHLOROETHANE	ND
29BH0006	3/6/2009	SW8260B	56.5	WA	1,2-DICHLOROPROPANE	ND
29BH0006	3/6/2009	SW8260B	56.5	WA	1,3,5-TRIMETHYLBENZENE (MESITYLENE)	BRL
29BH0006	3/6/2009	SW8260B	56.5	WA	1,3-DICHLOROBENZENE	ND
29BH0006	3/6/2009	SW8260B	56.5	WA	1,4-DICHLOROBENZENE	ND
29BH0006	3/6/2009	SW8260B	56.5	WA	BENZENE	ND
29BH0006	3/6/2009	SW8260B	56.5	WA	BROMOCHLOROMETHANE	ND
29BH0006	3/6/2009	SW8260B	56.5	WA	BROMODICHLOROMETHANE	ND
29BH0006	3/6/2009	SW8260B	56.5	WA	BROMOFORM	ND
29BH0006	3/6/2009	SW8260B	56.5	WA	BROMOMETHANE	ND
29BH0006	3/6/2009	SW8260B	56.5	WA	CARBON TETRACHLORIDE	ND
29BH0006	3/6/2009	SW8260B	56.5	WA	CHLOROBENZENE	ND
29BH0006	3/6/2009	SW8260B	56.5	WA	CHLOROETHANE	ND
29BH0006	3/6/2009	SW8260B	56.5	WA	CHLOROFORM	ND
29BH0006	3/6/2009	SW8260B	56.5	WA	CHLOROMETHANE	ND
29BH0006	3/6/2009	SW8260B	56.5	WA	cis-1,2-DICHLOROETHENE	ND
29BH0006	3/6/2009	SW8260B	56.5	WA	cis-1,3-DICHLOROPROPENE	ND
29BH0006	3/6/2009	SW8260B	56.5	WA	DIBROMOCHLOROMETHANE	ND
29BH0006	3/6/2009	SW8260B	56.5	WA	ETHYLBENZENE	BRL
29BH0006	3/6/2009	SW8260B	56.5	WA	M,P-XYLENE (SUM OF ISOMERS)	ND
29BH0006	3/6/2009	SW8260B	56.5	WA	METHYLENE CHLORIDE	ND
29BH0006	3/6/2009	SW8260B	56.5	WA	O-XYLENE (1,2-DIMETHYLBENZENE)	ND
29BH0006	3/6/2009	SW8260B	56.5	WA	STYRENE	ND
29BH0006	3/6/2009	SW8260B	56.5	WA	tert-BUTYL METHYL ETHER	ND
29BH0006	3/6/2009	SW8260B	56.5	WA	TETRACHLOROETHENE (PCE)	ND
29BH0006	3/6/2009	SW8260B	56.5	WA	TOLUENE	ND
29BH0006	3/6/2009	SW8260B	56.5	WA	trans-1,2-DICHLOROETHENE	ND
29BH0006	3/6/2009	SW8260B	56.5	WA	trans-1,3-DICHLOROPROPENE	ND
29BH0006	3/6/2009	SW8260B	56.5	WA	TRICHLOROETHENE (TCE)	ND
29BH0006	3/6/2009	SW8260B	56.5	WA	VINYL CHLORIDE	ND

Data Source: AFCEC, June 2009, MMR-AFCEE Data Warehouse

Key:

BRL = below reporting limit

WA = borehole water

ft bgs = feet below ground surface

µg/L = micrograms per liter

ND = nondetect

Attachment C-4
Remedial Investigation Sampling Results for AOC SD-4 Downgradient Study Area

TABLE 6-2
SURFACE SOIL SAMPLE FIXED-BASE LABORATORY CLP ANALYSIS SUMMARY

AOC SD-4 REMEDIAL INVESTIGATION
MASSACHUSSETTS MILITARY RESERVATION

SAMPLE NUMBER	MMR BKGRND. LEVEL	SS-1	SS-1 (duplicate)	SS-2	SS-3	SS-4	SS-5	SS-6	SS-6 (duplicate)	SS-13	SS-14
TCL VOCs (µg/kg)											
CARBON DISULFIDE	--	ND	ND	ND	ND	2 J	ND	ND	ND	ND	ND
CHLOROFORM	--	ND	ND	ND	ND	2 J	2 J	4 J	2 J	ND	ND
2-BUTANONE	--	ND	ND	ND	ND	ND	ND	ND	ND	17 J	ND
TRICHLOROETHENE (TCE)	--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
BENZENE	--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
TETRACHLOROETHENE (PCE)	--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
TOLUENE	--	ND	6 J	12 J	4 J	ND	1 J	2 J	ND	5 J	ND
ETHYLBENZENE	--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
TOTAL XYLENE	--	ND	6 J	ND	ND	ND	ND	12	ND	ND	ND
TCL VOC TICs (µg/kg)		1316 JN(6)	99 JN(2)	1254 JN(7)	223 JN(26)	0 JN(0)	0 JN(0)	38 JN(2)	0 JN(0)	82 JN(2)	17 JN(1)
TCL SVOCs (µg/kg)											
NAPHTHALENE	--	860 J	1100 J	ND	19 J	ND	10 J	15 J	12 J	1400 J	56 J
2-METHYLNAPHTHALENE	--	1600 J	2100 J	44 J	22 J	ND	16 J	25 J	19 J	2700 J	100 J
ACENAPHTHYLENE	--	160 J	190 J	ND	48 J	ND	ND	ND	ND	ND	ND
ACENAPHTHENE	--	170 J	190 J	ND	ND	ND	ND	ND	ND	240 J	ND
DIBENZOFURAN	--	450 J	580 J	ND	ND	ND	ND	ND	ND	730 J	29 J
FLUORENE	--	220 J	270 J	ND	ND	ND	ND	ND	ND	340 J	ND
PHENANTHRENE	--	2000 J	2500 J	390 J	120 J	7 J	36 J	57 J	48 J	2900	130 J
ANTHRACENE	--	200 J	250 J	41 J	24 J	ND	ND	ND	ND	220 J	13 J
CARBAZOLE	--	210 J	250 J	ND	ND	ND	ND	ND	ND	190 J	ND
DI-N-BUTYLPHTHALATE	--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
FLUORANTHENE	--	2800	3400	600 J	280 J	17 J	110 J	150 J	130 J	3800	150 J
PYRENE	--	2200 J	2800	490 J	210 J	14 J	67 J	100 J	93 J	2400 J	120 J
BENZO (A) ANTHRACENE	--	1400 J	1700 J	290 J	120 J	ND	30 J	42 J	45 J	1400 J	67 J
CHRYSENE	--	1800 J	2200 J	200 J	120 J	ND	48 J	61 J	68 J	2100 J	110 J
BIS (2-ETHYLHEXYL) PHTHALATE	--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
BENZO(B)FLUORANTHENE	--	4200 J	5000 J	450 J	320 J	ND	110 J	140 J	140 J	3900 J	200 J
BENZO(K) FLUORANTHENE	--	4200 J	5000 J	450 J	320 J	ND	110 J	140 J	140 J	3900 J	200 J
BENZO (A) PYRENE	--	1300 J	1600 J	140 J	100 J	8 J	38 J	53 J	53 J	1300 J	77 J
INDENO (1,2,3-CD) PYRENE	--	1000 J	1200 J	ND	62 J	8 J	34 J	59 J	48 J	1000 J	55 J
DIBENZO (A,H) ANTHRACENE	--	400 J	760 J	ND	ND	ND	ND	ND	ND	400 J	ND
BENZO (G,H,I) PERYLENE	--	840 J	1000 J	ND	51 J	ND	21 J	38 J	28 J	720 J	57 J
TOTAL SVOCs (µg/kg)		26010 J	32090 J	3095 J	1816 J	54 J	630 J	880 J	824 J	29640 J	1364 J
TCL SVOC TICs (µg/kg)		54680 JN(28)	62800 JN(28)	38890 JN(28)	90230 JN(26)	2561 JN(10)	16520 JN(25)	14000 JN(27)	11770 JN(27)	99700 JN(28)	8076 JN(2
TCL PEST/PCBs (µg/kg)											
DIELDRIN	--	210 J	220 J	13 J	15 J	ND	11	7.8 J	6.9 J	230 J	7.2 J
4,4'-DDE	--	ND	ND	12	3.7 J	ND	ND	ND	ND	ND	ND
4,4'-DDD	--	7.5 J	8 J	ND	ND	ND	ND	ND	ND	ND	ND
ENDOSULFAN SULFATE	--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4,4'-DDT	--	ND	ND	12 J	21	ND	5.1	6.3 J	5.9 J	ND	ND

TABLE 6-2
SURFACE SOIL SAMPLE FIXED-BASE LABORATORY CLP ANALYSIS SUMMARY

AOC SD-4 REMEDIAL INVESTIGATION
MASSACHUSSETTS MILITARY RESERVATION

SAMPLE NUMBER	MMR BKGRND. LEVEL	SS-1	SS-1 (duplicate)	SS-2	SS-3	SS-4	SS-5	SS-6	SS-6 (duplicate)	SS-13	SS-14
ALPHA-CHLORDANE	--	10 J	9.3 J	ND	ND	ND	ND	ND	ND	10	ND
AROCLOR-1260	--	3000 J	3000 J	61 J	50 J	22 J	96	54	57	4700 J	280
TAL INORGANICS (mg/kg)											
ALUMINUM	8930.00	15600 J	13500 J	5120 J	6210 J	965	2520	2000	1870	17200 J	2850 J
ANTIMONY	17.50	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
ARSENIC	3.60	10.5	11.5	2.6	4	1.1	1.6	1.7	1.2	11.7	2.3
BARIUM	10.40	91.8	80.5	29.6	21	1.5	7.9	5.5	4.8	95.2	24.2
BERYLLIUM	0.65	1.5	1.4	ND	ND	ND	ND	ND	ND	1.5	ND
CADMIUM	1.50	3	2.9	ND	1.5	ND	0.53	ND	ND	2.1	0.5
CALCIUM	969.00	2110	1730	2030	278	24.9 J	306	84.2	76.6	2120	ND
CHROMIUM	6.80	53.4	48.4	4.8	9.5	ND	5.1	2.2	2.3	52	2.7
COBALT	4.10	16.1	13.4	ND	1.4	ND	0.97	1.2	1.1	12.9	2.1
COPPER	5.20	158	133	9	8.7	1	3.4	3.9	2.9	140	6.7
IRON	12400.00	17700	15600	6260	7010	1580	4650	3030	2870	19600	4080
LEAD	12.05	508	671	40.1	116	3.4 J	9.8 J	14.5 J	13.3 J	465	29.4
MAGNESIUM	794.50	2200	1950	710	510	105	410	260	267	2830	267 J
MANGANESE	108.00	297 J	245 J	71.5 J	31.3 J	24.7	154	79.6	72.2	257 J	731 J
MERCURY	0.06	0.27	0.24	ND	0.15	ND	ND	ND	ND	0.41	0.13
NICKEL	5.20	25.5	21.6	6.6	5.3	ND	2.1	1	ND	24	1.9
POTASSIUM	551.00	977	852	793	440	ND	193	125	110	1070	ND
SELENIUM	0.33	4.7 J	3.7 J	ND	2 J	ND	ND	ND	ND	ND	ND
SILVER	1.40	1.9 J	1.3 J	ND	ND	ND	ND	ND	ND	1.1 J	ND
SODIUM	386.00	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
THALLIUM	0.25	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
VANADIUM	15.20	49.1	43.1	26.2	20.5	2.9	10.1	6	5.3	51.1	8.3
ZINC	16.00	194 J	165 J	ND	ND	4.5	14.2	10.3	9	190 J	ND
CYANIDE	0.70	1.2	1.1	0.29	ND	ND	ND	ND	0.08 J	0.68	0.07
TPH (Method 418.1 mg/kg)		1900.0	2100.0	180.00	220.00	15.00 J	42.00 J	43.00 J	34.00 J	2000.0	160.00

ABBREVIATIONS:

ND - Not detected

NA - Not analyzed

TPH - Total Petroleum Hydrocarbons

VOC TICs - Tentatively Identified Volatile Organic Compounds

SVOC TICs - Tentatively Identified Semivolatile Organic Compounds

VOCs - Volatile Organic Compounds

SVOCs - Semivolatile Organic Compounds

PEST/PCBs - Pesticides/PolyChlorinated Biphenyls

ft bgs - feet below ground surface

TCL - Target compound list

DATA QUALIFIERS:

J - Estimated value

JN(1) - Estimated value of TIC number in parentheses indicates quantity of TICs detected.

NOTES:

Shaded value indicates exceedance of MMR Background level.

-- - No level or standard

[ ] - Value exceeds MMR STCL for TPH. (500 mg/kg)

TABLE 6-4
SEDIMENT SOIL SAMPLE FIXED-BASE LABORATORY CLP ANALYSIS SUMMARY

AOC SD-4 REMEDIAL INVESTIGATION
MASSACHUSSETTS MILITARY RESERVATION

SAMPLE NUMBER	MMR BKGRD. LEVEL	SD-1	SD-1A	SD-2	SD-3	SD-4	SD-4 (5 ft bgs)	SD-5	SD-6	SD-7	SD-8
TCL VOCs (µg/kg)											
ACETONE	--	ND	ND	1300 J	ND	610 J	ND	ND	ND	ND	ND
CARBON DISULFIDE	--	ND	1 J	1 J	ND	ND	ND	ND	1 J	ND	1 J
1,2-DICHLOROETHENE (TOTAL)	--	ND	ND	1 J	ND	ND	ND	ND	ND	1 J	3 J
CHLOROFORM	--	ND	ND	ND	ND	ND	ND	2 J	ND	ND	ND
2-BUTANONE	--	7 J	ND	95	41 J	ND	5 J	ND	ND	5 J	7 J
TRICHLOROETHENE (TCE)	--	ND	ND	ND	ND	16 J	ND	ND	ND	2 J	ND
4-METHYL-2-PENTANONE	--	ND	ND	19	ND	ND	ND	ND	ND	ND	ND
TETRACHLOROETHENE (PCE)	--	ND	ND	ND	ND	27 J	ND	ND	ND	1 J	ND
TOLUENE	--	1 J	1 J	31	ND	ND	ND	ND	ND	4 J	ND
ETHYLBENZENE	--	ND	ND	1 J	ND	ND	ND	ND	ND	ND	ND
TOTAL XYLENE	--	5 J	ND	5 J	ND	ND	ND	ND	ND	ND	6 J
TCL VOC TICs (µg/kg)	--	5470 JN(10)	4990 JN(10)	5362 JN(10)	12210 JN(10)	25440 JN(10)	156 JN(4)	24 JN(2)	1069 JN(9)	7 JN(1)	11 JN(1)
TCL SVOCs (µg/kg)											
NAPHTHALENE	--	ND	44 J	37 J	ND	ND	ND	24 J	13 J	ND	ND
2-METHYLNAPHTHALENE	--	29 J	34 J	35 J	670 J	ND	ND	18 J	15 J	ND	ND
ACENAPHTHYLENE	--	27 J	40 J	ND	ND	ND	ND	ND	20 J	ND	ND
ACENAPHTHENE	--	ND	ND	21 J	180 J	ND	ND	ND	ND	ND	ND
DIBENZOFURAN	--	ND	33 J	23 J	ND	ND	ND	ND	ND	ND	ND
FLUORENE	--	28 J	33 J	31 J	330 J	ND	ND	ND	ND	ND	ND
PHENANTHRENE	--	220 J	230 J	150 J	1300 J	6000 J	ND	57 J	58 J	ND	32 J
ANTHRACENE	--	ND	ND	19 J	ND	800 J	ND	ND	ND	ND	ND
CARBAZOLE	--	44 J	39 J	21 J	ND	ND	ND	ND	ND	ND	ND
FLUORANTHENE	--	480	600	370 J	2200	15000	ND	140 J	140 J	ND	56 J
PYRENE	--	420	380 J	270 J	1600 J	10000	ND	120 J	130 J	10 J	42 J
BUTYLBENZYLPHTHALATE	--	ND	ND	ND	ND	ND	ND	ND	ND	ND	13 J
BENZO (A) ANTHRACENE	--	220 J	220 J	110 J	790 J	6200 J	ND	68 J	67 J	ND	ND
CHRYSENE	--	260 J	270 J	200 J	1000 J	6400 J	ND	90 J	99 J	ND	ND
BIS (2-ETHYLHEXYL) PHTHALATE	--	330 J	380 J	ND	3000 J	9000 J	ND	ND	ND	ND	ND
BENZO(B)FLUORANTHENE	--	600 J	650 J	370 J	1800 J	14000 J	ND	190 J	240 J	ND	51 J
BENZO(K) FLUORANTHENE	--	600 J	650 J	370 J	1800 J	14000 J	ND	190 J	240 J	ND	51 J
BENZO (A) PYRENE	--	180 J	220 J	140 J	650 J	4800 J	ND	80 J	73 J	ND	ND
INDENO (1,2,3-CD) PYRENE	--	180 J	220 J	110 J	570 J	4100 J	ND	79 J	110 J	ND	ND
DIBENZO (A,H) ANTHRACENE	--	69 J	84 J	43 J	190 J	1800 J	ND	ND	34 J	ND	ND
BENZO (G,H,I) PERYLENE	--	180 J	210 J	96 J	480 J	3100 J	ND	55 J	100 J	ND	ND
TOTAL SVOCs (µg/kg)		3867 J	4337 J	2416 J	16560 J	95200 J	0	1111 J	1339 J	10 J	245 J
TCL SVOC TICs (µg/kg)	--	43270 JN(29)	51650 JN(29)	111940 JN(29)	897000 JN(30)	1480000 JN(30)	75 JN(1)	17870 JN(26)	11900 JN(29)	18540 JN(28)	60990 JN(29)
TCL PEST/PCBs (µg/kg)											
HEPTACHLOR EPOXIDE	--	ND	ND	ND	ND	8.8 J	ND	ND	ND	ND	ND
DIELDRIN	--	19 J	15 J	4.1 J	21 J	120 J	ND	12 J	8.5 J	ND	ND
4,4'-DDE	--	ND	ND	ND	3.9 J	36 J	ND	ND	ND	ND	ND
4,4'-DDD	--	14	13	2.1 J	15 J	110 J	ND	ND	6.7	ND	ND

TABLE 6-4
SEDIMENT SOIL SAMPLE FIXED-BASE LABORATORY CLP ANALYSIS SUMMARY

AOC SD-4 REMEDIAL INVESTIGATION
MASSACHUSSETTS MILITARY RESERVATION

SAMPLE NUMBER	MMR BKGRD. LEVEL	SD-1	SD-1A	SD-2	SD-3	SD-4	SD-4 (5 ft bgs)	SD-5	SD-6	SD-7	SD-8
4,4'-DDT	--	ND	ND	ND	ND	ND	ND	6.6 J	ND	ND	ND
ALPHA-CHLORDANE	--	1.8 J	1.3 J	ND	ND	10 J	ND	ND	ND	ND	ND
GAMMA-CHLORDANE	--	3.7	ND	ND	ND	19 J	ND	ND	ND	ND	ND
AROCLOR-1242	--	ND	ND	ND	53 J	310 J	ND	ND	ND	ND	ND
AROCLOR-1248	--	28 J	28 J	ND	ND	ND	ND	ND	ND	ND	ND
AROCLOR-1260	--	140	130	22 J	97 J	760 J	ND	85	84	ND	ND
TAL INORGANICS (mg/kg)											
ALUMINUM	8930.00	2430	1790	4560	14100	20400	ND	2850	2200	505	1250
ANTIMONY	17.50	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
ARSENIC	3.60	1.4	1.3	1.6	6.1	4.9	3.3	1.6	0.67 J	ND	ND
BARIUM	10.40	11.2	10.4	8.3	44.2	77.9	2.3	7	9.5	4	11.7
BERYLLIUM	0.65	ND	ND	ND	0.44	0.61	ND	ND	ND	ND	ND
CADMIUM	1.50	1.6	1.4	0.97	6.6	19	ND	ND	1	0.55	ND
CALCIUM	969.00	156	115	97.6	737	1190	ND	150	131	104	302
CHROMIUM	6.80	11.4	8.9	5.3	32.5	62.7	2.6	2.9	6.8	3	2.8
COBALT	4.10	1.5	1.6	3.3	5.3	6.6	ND	0.76	0.86	ND	ND
COPPER	5.20	8.1	6.2	4.8	34.9	63.8	0.99	4.2	5	1.5	0.98
IRON	12400.00	3330	3110	6790	10900	15600	5470	3810	2830	337	1100
LEAD	12.05	79.6	76	45.3	477	603	4	19.4	52.7	2.6	6.7
MAGNESIUM	794.50	363	187	1220	1730	2340	489 J	343	322	78.2	299
MANGANESE	108.00	17.8	13.7	61.2	71.7	89.3	24.7	59.9	21.9	4.5	13.3
MERCURY	0.06	ND	ND	ND	ND	ND	ND	0.36 J	ND	ND	0.22
NICKEL	5.20	3.8	3.7	6.6	12.8	19.6	3.7	2.4	2.4	1.3	1.3
POTASSIUM	551.00	230	185	335	783	1170	ND	151	204	121	213
SELENIUM	0.33	ND	ND	0.44	0.67	0.65	ND	ND	0.42	0.29	0.42
SILVER	1.40	ND	ND	ND	ND	4.5	ND	ND	ND	ND	ND
SODIUM	386.00	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
THALLIUM	0.25	ND	ND	ND	ND	ND	ND	0.29	ND	ND	ND
VANADIUM	15.20	6.1	6.1	11.5	29.2	46.7	9.1	8.2	6.2	1.4	2.2
ZINC	16.00	ND	ND	ND	ND	308	ND	8.7	ND	ND	ND
CYANIDE	0.70	0.16	0.13 J	ND	ND	0.2 J	ND	ND	0.07 J	ND	0.17
TPH (Method 418.1 mg/kg)	--	1500 J	1400 J	560 J	19000 J	64000 J	ND	R	720 J	ND	ND

ABBREVIATIONS:

TPH - Total Petroleum Hydrocarbons
VOC TICs - Tentatively Identified Volatile Organic Compounds
SVOC TICs - Tentatively Identified Semivolatile Organic Compounds
ND - Not detected
VOCs - Volatile Organic Compounds
SVOCs - Semivolatile Organic Compounds
PEST/PCBs - Pesticides/Polychlorinated biphenyls
ft bgs - feet below ground surface
TCL - Target compound list
mg/kg - milligram per kilogram
µg/kg - microgram per kilogram

DATA QUALIFIERS:

JN(1) - Estimated value of TIC number in parentheses indicates quantity of TICs detected.
J - Estimated value
R - Rejected

NOTES:

Shaded value indicates exceedence of MMR Background level.(subsurface background levels used for SD-4 (5 ft bgs), see Table 6-6.)
-- No level or standard
Value exceeds MMR STCL for TPH. (500 mg/kg)

TB6-4SD4.WK4 12:15 PM 11/02/95

APPENDIX D

Technical Evaluations in Support of Land Use Control Program

WELL DETERMINATION

ADDRESS: 360 Nathan Ellis Highway, Falmouth MA

APEMS ID: 39561

WELL STATUS: ACTIVE

WELL USE: Irrigation/outdoor use

SUMMARY: According to the property owner response, which is included in the parcel summary report (attached), there is a private well located on this property that is used for outdoor irrigation purposes. This property is connected to the Falmouth municipal water supply. This residence receives a water bill from the Town of Falmouth. The total depth of this well is unknown. Depth to water in this area is approximately 65 ft bgs (39 ft msl).

DATA REVIEW:

- ☑ SPEIM monitoring data are available in the vicinity of this well [see attached map, cross section I-I' and table]
  - 69MW1514A,B (-181 ft msl and -59 ft msl, respectively)
  - 82MW00019A,B (-210 ft msl and -58 ft msl, respectively)
  - 82MW0017B (-93 ft msl)
- ☑ SPEIM monitoring data indicate the CS-21 plume is being captured by extraction well 82EW0001, which began operation in 2006 and is located approximately 1,000 feet hydraulically crossgradient of 360 Nathan Ellis Highway (Map attached). The top of the CS-21 plume near 360 Nathan Ellis Highway is approximately 150 feet below the water table (i.e., at approximately -110 ft msl ; as defined by NDs at 82MW0019B). TCE concentrations in this portion of the plume are decreasing (69MW1514B, -59 ft msl).

- ☑ A sample was collected from this well in May 2013 and submitted for VOC analysis. No TCE was detected (Laboratory Report attached). This well was also sampled 29 times between 1997 and 1999 (table attached). TCE was detected at concentrations below the laboratory reporting limit (BRL) of 0.5 µg/L in three samples collected between December 1997 and January 1998. TCE was not detected in any other samples collected from this well.

DETERMINATION: No TCE was detected in a sample collected from the private irrigation well at 360 Nathan Ellis Highway in May 2013. Therefore, there is no current risk of exposure to the CS-21 plume at this time. The top of the CS-21 plume near 360 Nathan Ellis Highway is approximately 150 feet below the water table. The depth of the private well on this property is not known, but it is likely to be screened shallower in the aquifer than the CS-21 plume and it is unlikely that intermittent operation of this well will result in TCE concentrations above the MCL. This determination is supported by current and historic sampling of the private well at 360 Nathan Ellis Highway.

PATH FORWARD: No further evaluation or sampling is required**.**

SAMPLING NEEDED: ☐ **Yes** ☒ **No**

RE-EVALUATE IN NEXT 5-YEAR REVIEW: ☒ **Yes** ☐ **No**

AFCEC MMR Land Use Controls
Parcel Summary

Report Produced: 7/10/2013

Name: WREDE J SCOTT, TRACEY J

Plume: CS21 *Telephone No.* 508-563-7967

Mailing Address

AFCEE Plume: CS21

Mailing PO:

Mailing Street: PO BOX 903

Mailing City: NORTH FALMOUTH

Mailing State: MA

Mailing ZIP: 02556-0903

Town Numbers

Map: 06 *Section:* 02 *Parcel:* 002 *Lot:* 001

Residential Well Notes: 4-13-2013. Per owner's call, the well is used for irrigation purposes and has been for 11 years. Previously listed as non-functional. Is willing to have it tested.

Irrigation Well Notes:

Town Water Notes: Existing Town of Falmouth water account (May 2007)

Other Notes:

Parcel Address

APEMS ID: 39561

Parcel Street: 360 NATHAN S ELLIS HWY

Parcel City: Falmouth

Parcel State:

Parcel ZIP:

☐ Checked if the parcel respond to the state's 5-Star survey.

☐ Checked if AFCEE has been in contact with the parcel and no contact is needed.

Initial Mailing Sent? ☑ *Date Sent:* 6/1/2009 *Date Returned:* 6/22/2009

Second Mailing Sent? ☐ *Date Sent:* *Date Returned:*

Third Mailing Sent? ☐ *Date Sent:* *Date Returned:*

Contacted by Phone? ☐ *Date Contacted:* *Contact Note:*

Contacted by Email? ☐ *Email Date:* *Date Returned::*

Contacted In-Person? ☐ *Date Contacted:*

Field Visit Performed? ☐ *Field Visit Date:* *Field Visit Note:*

Other Contact Notes: Any

Wells associated with this parcel:

LocID

Functional? ☑ ***Depth*** 0 ***Decomissioned?*** ☐ ***Well Deemed Safe?*** ☐

Non-Functional? ☐ ***Pump Rate*** 0 ***Decomission Offer Made?*** ☐ ***Date:***

Other Status? ***Decomission Offer Received?*** ☐

Originating Source:

Path: Y:\Figures\General\LUC\2013\5thYrReview\LUC_13LUC_39561_NathanEllis360.mxd Date: 7/10/2013 Time: 9:03:12 AM User: 1268507872E

Legend

- Plume Boundary
- LUC Area
- Parcel of Interest *
- Other Parcel
- Monitoring Well
- Extraction Well

* Note: Private Well Sampled in 2013

N

0 300 600 Feet

Data Source: AFCEC, MMR-AFCEC Data Warehouse

LOCATION: 360 NATHAN ELLIS HWY

AFCEC - Massachusetts Military Reservation

CS-21 Land Use Control

CH2MHILL

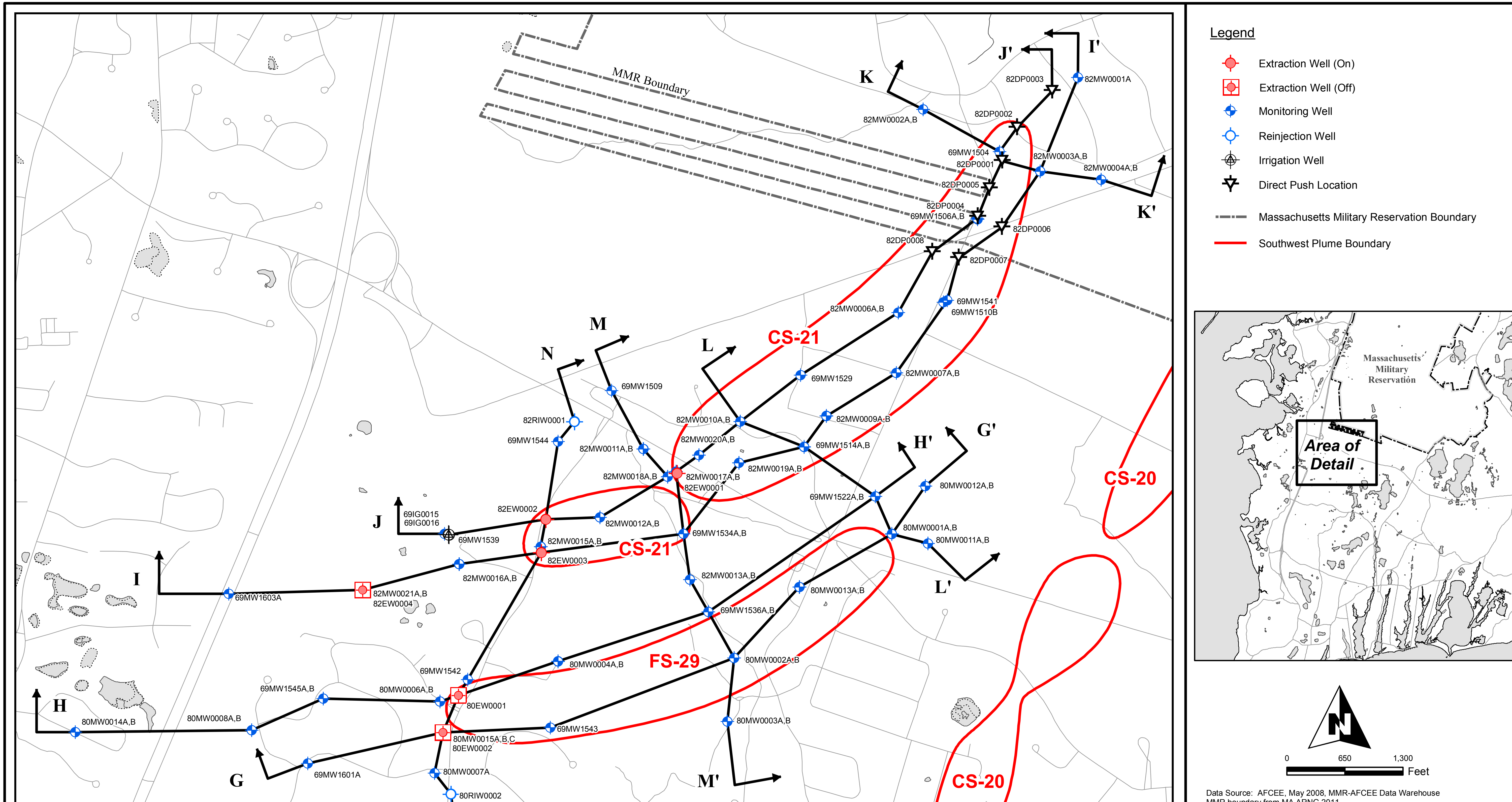


FIGURE A-3

CS-21 AND FS-29 PLUMES AND LOCATION CROSS-SECTION LINES

AFCEE - Massachusetts Military Reservation

Fuel Spill-28 and Southwest Plumes 2011 Private Well Verification and Well Determination Project Note

CH2MHILL.

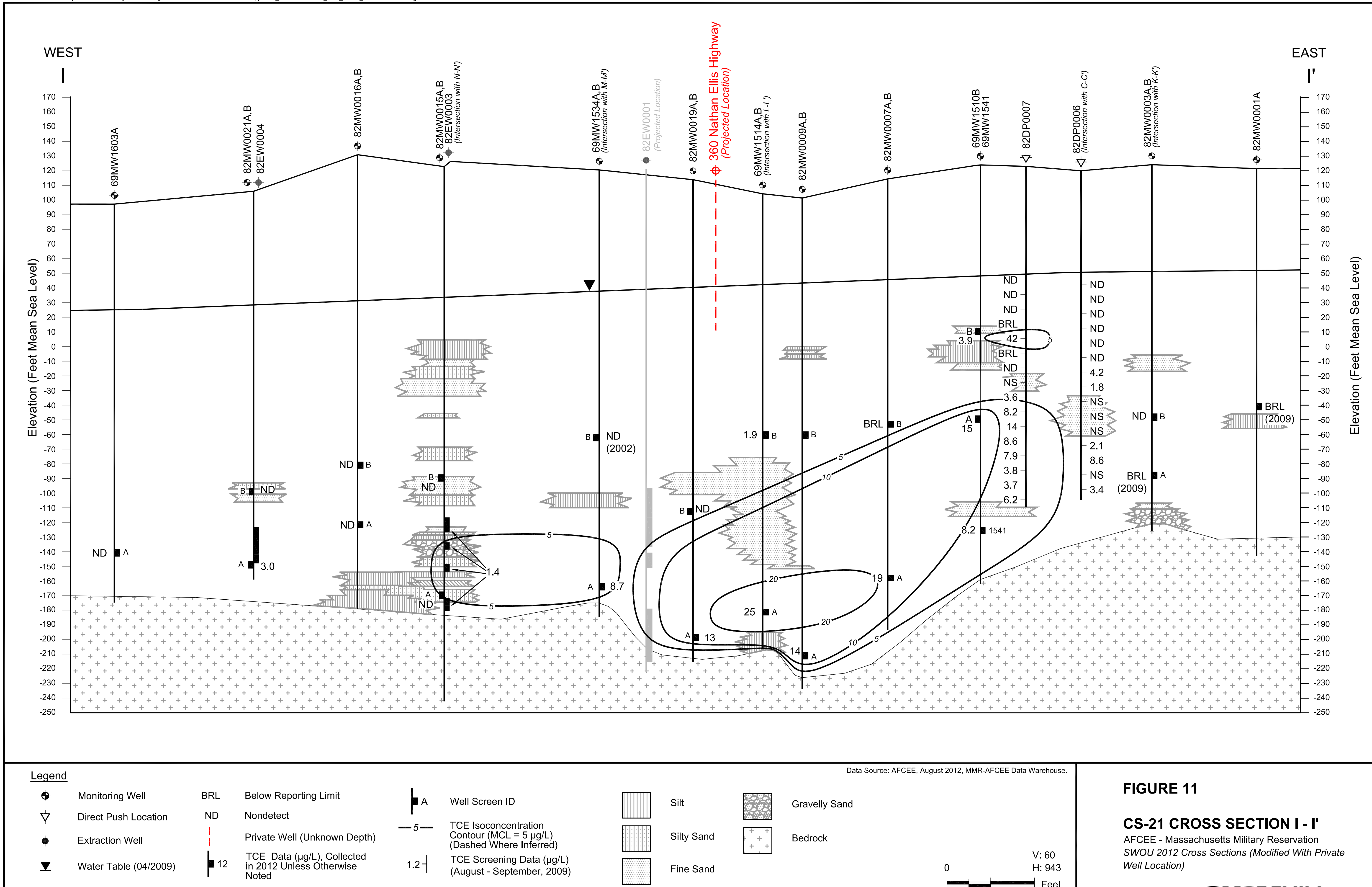


FIGURE 11

CS-21 CROSS SECTION I - I'

AFCEE - Massachusetts Military Reservation

SWOU 2012 Cross Sections (Modified With Private Well Location)

CH2MHILL.

Summary of Groundwater Monitoring Results for TCE
CS-21 Area

Location	Matrix	Test	Analyte	Depth (ft bgs)	Date	Result	DL	RL	Units
69MW1514A	WA	SW8260	TRICHLOROETHENE (TCE)	72.5	3/16/1998	ND	0.318	1	µg/L
69MW1514A	WA	SW8260	TRICHLOROETHENE (TCE)	83.5	3/16/1998	ND	0.318	1	µg/L
69MW1514A	WA	SW8260	TRICHLOROETHENE (TCE)	93.5	3/16/1998	ND	0.318	1	µg/L
69MW1514A	WA	SW8260	TRICHLOROETHENE (TCE)	103.5	3/16/1998	ND	0.318	1	µg/L
69MW1514A	WA	SW8260	TRICHLOROETHENE (TCE)	113.5	3/16/1998	BRL	0.318	1	µg/L
69MW1514A	WA	SW8260	TRICHLOROETHENE (TCE)	125.5	3/16/1998	5.31	0.318	1	µg/L
69MW1514A	WA	SW8260	TRICHLOROETHENE (TCE)	133.5	3/16/1998	7.72	0.318	1	µg/L
69MW1514A	WA	SW8260	TRICHLOROETHENE (TCE)	145	3/17/1998	6.51	0.318	1	µg/L
69MW1514A	WA	SW8260	TRICHLOROETHENE (TCE)	155	3/17/1998	4.35	0.318	1	µg/L
69MW1514A	WA	SW8260	TRICHLOROETHENE (TCE)	165	3/17/1998	16.5	0.318	1	µg/L
69MW1514A	WA	SW8260	TRICHLOROETHENE (TCE)	175	3/17/1998	7.75	0.318	1	µg/L
69MW1514A	WA	SW8260	TRICHLOROETHENE (TCE)	185	3/17/1998	8.19	0.318	1	µg/L
69MW1514A	WA	SW8260	TRICHLOROETHENE (TCE)	195	3/17/1998	10.6	0.318	1	µg/L
69MW1514A	WA	SW8260	TRICHLOROETHENE (TCE)	205	3/17/1998	7.55	0.318	1	µg/L
69MW1514A	WA	SW8260	TRICHLOROETHENE (TCE)	215	3/18/1998	1.58	0.318	1	µg/L
69MW1514A	WA	SW8260	TRICHLOROETHENE (TCE)	225	3/18/1998	6.55	0.318	1	µg/L
69MW1514A	WA	SW8260	TRICHLOROETHENE (TCE)	235	3/18/1998	4.25	0.318	1	µg/L
69MW1514A	WA	SW8260	TRICHLOROETHENE (TCE)	243	3/18/1998	7.78	0.318	1	µg/L
69MW1514A	WA	SW8260	TRICHLOROETHENE (TCE)	255	3/19/1998	6.51	0.318	1	µg/L
69MW1514A	WA	SW8260	TRICHLOROETHENE (TCE)	264	3/19/1998	3.08	0.318	1	µg/L
69MW1514A	WA	SW8260	TRICHLOROETHENE (TCE)	274	3/19/1998	28	0.318	1	µg/L
69MW1514A	WA	SW8260	TRICHLOROETHENE (TCE)	285	3/19/1998	28.5	0.318	1	µg/L
69MW1514A	WA	SW8260	TRICHLOROETHENE (TCE)	294	3/19/1998	11.3	0.318	1	µg/L
69MW1514A	WA	SW8260	TRICHLOROETHENE (TCE)	304.5	3/20/1998	11	0.318	1	µg/L
69MW1514A	WA	SW8260	TRICHLOROETHENE (TCE)	309	3/20/1998	10.3	0.318	1	µg/L
69MW1514A	WG	CVOL	TRICHLOROETHENE (TCE)	285.6	4/29/1998	47	0.32	2	µg/L
69MW1514A	WG	CVOL	TRICHLOROETHENE (TCE)	285.6	9/11/2000	40	0.18	2	µg/L
69MW1514A	WG	SW8260	TRICHLOROETHENE (TCE)	285.6	6/10/2002	37.1	0.138	1	µg/L
69MW1514A	WG	SW8260B	TRICHLOROETHENE (TCE)	285.6	6/8/2006	27.6	0.21	1	µg/L
69MW1514A	WG	SW8260B	TRICHLOROETHENE (TCE)	285.6	3/12/2007	21.6	0.15	1	µg/L
69MW1514A	WG	SW8260B	TRICHLOROETHENE (TCE)	285.6	3/26/2008	19.6	0.15	1	µg/L
69MW1514A	WG	SW8260B	TRICHLOROETHENE (TCE)	285.6	5/5/2009	11.7	0.15	1	µg/L
69MW1514A	WG	SW8260B	TRICHLOROETHENE (TCE)	285.6	3/29/2010	15	0.17	1	µg/L
69MW1514A	WG	SW8260B	TRICHLOROETHENE (TCE)	285.6	4/1/2011	24	0.2	1	µg/L
69MW1514A	WG	SW8260B	TRICHLOROETHENE (TCE)	285.6	2/24/2012	25	0.2	1	µg/L
69MW1514A	WG	SW8260B	TRICHLOROETHENE (TCE)	285.6	3/13/2013	23	0.2	1	µg/L
69MW1514B	WG	CVOL	TRICHLOROETHENE (TCE)	164.75	4/29/1998	9.7	0.16	1	µg/L
69MW1514B	WG	CVOL	TRICHLOROETHENE (TCE)	164.75	9/11/2000	6.4	0.09	1	µg/L
69MW1514B	WG	SW8260	TRICHLOROETHENE (TCE)	164.75	6/10/2002	5.32	0.138	1	µg/L
69MW1514B	WG	SW8260B	TRICHLOROETHENE (TCE)	164.75	6/8/2006	12.6	0.21	1	µg/L
69MW1514B	WG	SW8260B	TRICHLOROETHENE (TCE)	164.75	3/12/2007	36.7	0.15	1	µg/L
69MW1514B	WG	SW8260B	TRICHLOROETHENE (TCE)	164.75	4/9/2008	29.7	0.15	1	µg/L
69MW1514B	WG	SW8260B	TRICHLOROETHENE (TCE)	164.75	5/5/2009	19.7	0.15	1	µg/L
69MW1514B	WG	SW8260B	TRICHLOROETHENE (TCE)	164.75	3/29/2010	7.2	0.17	1	µg/L
69MW1514B	WG	SW8260B	TRICHLOROETHENE (TCE)	164.75	4/8/2011	5.4	0.2	1	µg/L
69MW1514B	WG	SW8260B	TRICHLOROETHENE (TCE)	164.75	4/20/2012	1.9	0.2	1	µg/L
82MW0017A	WA	SW8260	TRICHLOROETHENE (TCE)	112.5	8/6/2002	ND	0.138	1	µg/L
82MW0017A	WA	SW8260	TRICHLOROETHENE (TCE)	122.5	8/7/2002	ND	0.138	1	µg/L
82MW0017A	WA	SW8260	TRICHLOROETHENE (TCE)	132.5	8/7/2002	ND	0.138	1	µg/L
82MW0017A	WA	SW8260	TRICHLOROETHENE (TCE)	142.5	8/7/2002	1.99	0.138	1	µg/L
82MW0017A	WA	SW8260	TRICHLOROETHENE (TCE)	152.5	8/7/2002	2.12	0.138	1	µg/L
82MW0017A	WA	SW8260	TRICHLOROETHENE (TCE)	162.5	8/7/2002	BRL	0.138	1	µg/L
82MW0017A	WA	SW8260	TRICHLOROETHENE (TCE)	172.5	8/7/2002	ND	0.138	1	µg/L
82MW0017A	WA	SW8260	TRICHLOROETHENE (TCE)	182.5	8/8/2002	BRL	0.138	1	µg/L
82MW0017A	WA	SW8260	TRICHLOROETHENE (TCE)	192.5	8/8/2002	ND	0.138	1	µg/L
82MW0017A	WA	SW8260	TRICHLOROETHENE (TCE)	202.5	8/8/2002	1.7	0.138	1	µg/L
82MW0017A	WA	SW8260	TRICHLOROETHENE (TCE)	212.5	8/8/2002	16.1	0.138	1	µg/L
82MW0017A	WA	SW8260	TRICHLOROETHENE (TCE)	222.5	8/9/2002	15.5	0.138	1	µg/L
82MW0017A	WA	SW8260	TRICHLOROETHENE (TCE)	232.5	8/9/2002	18.4	0.138	1	µg/L

Private Well Sampling Results
360 Nathan Ellis Highway

Location	Date	Test	Analyte	Result	DL	RL	Units
RS0360NAEL	12/2/1997	E524.2	TRICHLOROETHENE (TCE)	ND	0.39	0.5	µg/L
RS0360NAEL	12/23/1997	E524.2	TRICHLOROETHENE (TCE)	BRL	0.16	0.5	µg/L
RS0360NAEL	12/30/1997	E524.2	TRICHLOROETHENE (TCE)	BRL	0.16	0.5	µg/L
RS0360NAEL	1/12/1998	E524.2	TRICHLOROETHENE (TCE)	BRL	0.16	0.5	µg/L
RS0360NAEL	2/10/1998	E524.2	TRICHLOROETHENE (TCE)	ND	0.16	0.5	µg/L
RS0360NAEL	2/23/1998	E524.2	TRICHLOROETHENE (TCE)	ND	0.16	0.5	µg/L
RS0360NAEL	3/10/1998	E524.2	TRICHLOROETHENE (TCE)	ND	0.16	0.5	µg/L
RS0360NAEL	3/24/1998	E524.2	TRICHLOROETHENE (TCE)	ND	0.16	0.5	µg/L
RS0360NAEL	4/7/1998	E524.2	TRICHLOROETHENE (TCE)	ND	0.16	0.5	µg/L
RS0360NAEL	4/21/1998	E524.2	TRICHLOROETHENE (TCE)	ND	0.16	0.5	µg/L
RS0360NAEL	5/5/1998	E524.2	TRICHLOROETHENE (TCE)	ND	0.16	0.5	µg/L
RS0360NAEL	6/3/1998	E524.2	TRICHLOROETHENE (TCE)	ND	0.075	0.5	µg/L
RS0360NAEL	6/16/1998	E524.2	TRICHLOROETHENE (TCE)	ND	0.075	0.5	µg/L
RS0360NAEL	6/30/1998	E524.2	TRICHLOROETHENE (TCE)	ND	0.075	0.5	µg/L
RS0360NAEL	8/11/1998	E524.2	TRICHLOROETHENE (TCE)	ND	0.075	0.5	µg/L
RS0360NAEL	8/25/1998	E524.2	TRICHLOROETHENE (TCE)	ND	0.075	0.5	µg/L
RS0360NAEL	9/22/1998	E524.2	TRICHLOROETHENE (TCE)	ND	0.14	0.5	µg/L
RS0360NAEL	10/6/1998	E524.2	TRICHLOROETHENE (TCE)	ND	0.14	0.5	µg/L
RS0360NAEL	10/19/1998	E524.2	TRICHLOROETHENE (TCE)	ND	0.14	0.5	µg/L
RS0360NAEL	11/16/1998	E524.2	TRICHLOROETHENE (TCE)	ND	0.14	0.5	µg/L
RS0360NAEL	12/1/1998	E524.2	TRICHLOROETHENE (TCE)	ND	0.14	0.5	µg/L
RS0360NAEL	12/16/1998	E524.2	TRICHLOROETHENE (TCE)	ND	0.14	0.5	µg/L
RS0360NAEL	12/29/1998	E524.2	TRICHLOROETHENE (TCE)	ND	0.14	0.5	µg/L
RS0360NAEL	1/12/1999	E524.2	TRICHLOROETHENE (TCE)	ND	0.14	0.5	µg/L
RS0360NAEL	2/9/1999	E524.2	TRICHLOROETHENE (TCE)	ND	0.14	0.5	µg/L
RS0360NAEL	2/23/1999	E524.2	TRICHLOROETHENE (TCE)	ND	0.14	0.5	µg/L
RS0360NAEL	3/9/1999	E524.2	TRICHLOROETHENE (TCE)	ND	0.14	0.5	µg/L
RS0360NAEL	3/23/1999	E524.2	TRICHLOROETHENE (TCE)	ND	0.14	0.5	µg/L
RS0360NAEL	4/6/1999	E524.2	TRICHLOROETHENE (TCE)	ND	0.14	0.5	µg/L

Data Source: AFCEC-MMR Data Warehouse, July 2013

Key:

BRL = below reporting limit

DL = detection limit

ND = non detect

RL = reporting limit

µg/L = micrograms per liter

Summary of Groundwater Monitoring Results for TCE
CS-21 Area

Location	Matrix	Test	Analyte	Depth (ft bgs)	Date	Result	DL	RL	Units
82MW0017A	WA	SW8260	TRICHLOROETHENE (TCE)	242.5	8/9/2002	16	0.138	1	µg/L
82MW0017A	WA	SW8260	TRICHLOROETHENE (TCE)	252.5	8/12/2002	17	0.138	1	µg/L
82MW0017A	WA	SW8260	TRICHLOROETHENE (TCE)	262.5	8/13/2002	19.1	0.138	1	µg/L
82MW0017A	WA	SW8260	TRICHLOROETHENE (TCE)	272.5	8/13/2002	1.72	0.138	1	µg/L
82MW0017A	WA	SW8260	TRICHLOROETHENE (TCE)	302.5	8/13/2002	16.8	0.138	1	µg/L
82MW0017A	WA	SW8260	TRICHLOROETHENE (TCE)	312.5	8/14/2002	4.01	0.138	1	µg/L
82MW0017A	WA	SW8260	TRICHLOROETHENE (TCE)	322.5	8/14/2002	12.4	0.138	1	µg/L
82MW0017A	WA	SW8260	TRICHLOROETHENE (TCE)	332.5	8/14/2002	38.2	0.138	1	µg/L
82MW0017A	WA	SW8260	TRICHLOROETHENE (TCE)	342.5	8/15/2002	8.76	0.138	1	µg/L
82MW0017A	WG	SW8260B	TRICHLOROETHENE (TCE)	319.6	6/15/2006	24.4	0.15	1	µg/L
82MW0017A	WG	SW8260B	TRICHLOROETHENE (TCE)	319.6	4/29/2009	12.7	0.15	1	µg/L
82MW0017A	WG	SW8260B	TRICHLOROETHENE (TCE)	319.6	4/16/2012	14	0.2	1	µg/L
82MW0017B	WG	SW8260B	TRICHLOROETHENE (TCE)	216.55	6/15/2006	16.3	0.15	1	µg/L
82MW0017B	WG	SW8260B	TRICHLOROETHENE (TCE)	216.55	4/29/2009	ND	0.15	1	µg/L
82MW0017B	WG	SW8260B	TRICHLOROETHENE (TCE)	216.55	4/16/2012	ND	0.2	1	µg/L
82MW0019A	WA	SW8260	TRICHLOROETHENE (TCE)	122.5	9/6/2002	ND	0.138	1	µg/L
82MW0019A	WA	SW8260	TRICHLOROETHENE (TCE)	132.5	9/6/2002	ND	0.138	1	µg/L
82MW0019A	WA	SW8260	TRICHLOROETHENE (TCE)	142.5	9/6/2002	ND	0.138	1	µg/L
82MW0019A	WA	SW8260	TRICHLOROETHENE (TCE)	152.5	9/6/2002	ND	0.138	1	µg/L
82MW0019A	WA	SW8260	TRICHLOROETHENE (TCE)	162.5	9/6/2002	ND	0.138	1	µg/L
82MW0019A	WA	SW8260	TRICHLOROETHENE (TCE)	172.5	9/7/2002	ND	0.138	1	µg/L
82MW0019A	WA	SW8260	TRICHLOROETHENE (TCE)	182.5	9/7/2002	ND	0.138	1	µg/L
82MW0019A	WA	SW8260	TRICHLOROETHENE (TCE)	192.5	9/7/2002	ND	0.138	1	µg/L
82MW0019A	WA	SW8260	TRICHLOROETHENE (TCE)	202.5	9/7/2002	ND	0.138	1	µg/L
82MW0019A	WA	SW8260	TRICHLOROETHENE (TCE)	212.5	9/7/2002	ND	0.138	1	µg/L
82MW0019A	WA	SW8260	TRICHLOROETHENE (TCE)	232.5	9/7/2002	ND	0.138	1	µg/L
82MW0019A	WA	SW8260	TRICHLOROETHENE (TCE)	252.5	9/9/2002	ND	0.138	1	µg/L
82MW0019A	WA	SW8260	TRICHLOROETHENE (TCE)	272.5	9/9/2002	1.9	0.138	1	µg/L
82MW0019A	WA	SW8260	TRICHLOROETHENE (TCE)	292.5	9/9/2002	26.6	0.138	1	µg/L
82MW0019A	WA	SW8260	TRICHLOROETHENE (TCE)	312.5	9/10/2002	8.64	0.138	1	µg/L
82MW0019A	WG	SW8260B	TRICHLOROETHENE (TCE)	312.5	8/8/2006	13.2	0.15	1	µg/L
82MW0019A	WG	SW8260B	TRICHLOROETHENE (TCE)	312.5	5/12/2009	22.9	0.15	1	µg/L
82MW0019A	WG	SW8260B	TRICHLOROETHENE (TCE)	312.5	3/6/2012	13	0.2	1	µg/L
82MW0019B	WG	SW8260B	TRICHLOROETHENE (TCE)	226.42	8/8/2006	ND	0.15	1	µg/L
82MW0019B	WG	SW8260B	TRICHLOROETHENE (TCE)	226.42	5/12/2009	ND	0.15	1	µg/L
82MW0019B	WG	SW8260B	TRICHLOROETHENE (TCE)	226.42	3/6/2012	ND	0.2	1	µg/L

Data Source: AFCEC-MMR Data Warehouse, July 2013

Key:

BRL = below reporting limit

DL = detection limit

ft bgs = feet below ground surface

ND = non detect

µg/L = micrograms per liter

RL = reporting limit

WG = groundwater sample

WA = groundwater vertical profiling sample

analytics environmental laboratory LLC
195 Commerce Way
Portsmouth, New Hampshire 03801
603-436-5111 Fax 603-430-2151
800-929-9906

Mr. Doug Scott
CH2M Hill
1748 West Truck Road/Otis ANG Base
Buzzards Bay MA 02542

June 6, 2013

SAMPLE DATA

Lab Sample ID:	75664-3
Matrix:	Aqueous
Percent Solid:	N/A
Dilution Factor:	1
Collection Date:	05/30/13
Lab Receipt Date:	05/31/13
Analysis Date:	06/05/13

CLIENT SAMPLE ID

Project Name:	MMR 2013/05 LUC CS-10, CS-21, AV
Project Number:	437075.05.07.18
Field Sample ID:	CHPR0360NA-O0513

ANALYTICAL RESULTS VOLATILE ORGANICS

COMPOUND	Detection Limit µg/L	Quantitation Limit µg/L	Result µg/L	COMPOUND	Detection Limit µg/L	Quantitation Limit µg/L	Result µg/L
1,1,1-Trichloroethane	0.18	1.0	U	Toluene	0.20	1.0	U
1,1-Dichloroethane	0.20	1.0	U	trans-1,2-Dichloroethene	0.20	1.0	U
1,2,4-Trichlorobenzene	0.21	1.0	U	trans-1,3-Dichloropropene	0.10	1.0	U
1,2-Dibromo-3-chloropropane	0.50	1.0	U	Trichloroethene	0.20	1.0	U
1,2-Dichlorobenzene	0.16	1.0	U	1,1,2,2-Tetrachloroethane	0.13	1.0	U
1,3-Dichlorobenzene	0.20	1.0	U	1,1,2-Trichloroethane	0.11	1.0	U
1,4-Dichlorobenzene	0.19	1.0	U	1,1-Dichloroethene	0.13	1.0	U
Benzene	0.20	1.0	U	1,2-Dibromoethane	0.15	1.0	U
Bromochloromethane	0.20	1.0	U	1,2-Dichloroethane	0.50	1.0	U
Chlorobenzene	0.17	1.0	U	1,2-Dichloropropane	0.50	1.0	U
Chloroform	0.20	1.0	**0.75 J**	Bromodichloromethane	0.15	1.0	U
cis-1,2-Dichloroethene	0.20	1.0	U	Bromoform	0.12	1.0	U
cis-1,3-Dichloropropene	0.10	1.0	U	Bromomethane	0.50	1.0	U
Ethylbenzene	0.20	1.0	U	Carbon Tetrachloride	0.20	1.0	U
Methylene Chloride	1.0	2.0	U	Chloroethane	0.50	1.0	U
o-Xylene	0.20	1.0	U	Chloromethane	0.20	1.0	U
m,p-Xylene	0.40	1.0	U	Dibromochloromethane	0.15	1.0	U
Styrene	0.20	1.0	U	Methyl-tert-butyl ether (MTBE)	0.20	1.0	U
Tetrachloroethene	0.19	1.0	U	Vinyl chloride	0.20	1.0	U

Surrogate Standard Recovery

Bromofluorobenzene	99%	d4-1,2-Dichloroethane	101%	d8-Toluene	101%

U=Undetected J=Estimated E=Exceeds Calibration Range B=Detected in Blank

METHODOLOGY: Sample analysis was conducted according to: Test Methods for Evaluating Solid Waste, SW-846 Method 8260B.

COMMENTS:

set2ColumnMDLandDL:Res(0):Rec(0) - CH2MMR(BI)-AQ-Short(noTMBs)_7_27_10

Authorized signature

WELL DETERMINATION

ADDRESS: 539 Currier Road, Falmouth MA

APEMS ID: 39899

WELL STATUS: ACTIVE

WELL USE: Outdoor uses

SUMMARY: According to the property owner response (attached), this residence is connected to the Falmouth municipal water supply. This residence receives a water bill from the Town of Falmouth. However, there is a private well located on this property that is used for outdoor purposes. The total depth of this well is unknown. Depth to water in this area is approximately 12 ft bgs (+45 ft msl). This property is located along the southern border of the Ashumet Valley LTM area, approximately 580 feet north and outside of the Ashumet Valley Plume boundary.

DATA REVIEW:

☑ SPEIM monitoring data are available in the vicinity of this well [see attached map and cross sections].

- 03MW1059A,B,C [vertical profiling and monitoring data; tables attached]
- 30MW0583A,B,C,D,E [monitoring data; table attached]
- Water table elevation is approximately 45 ft msl.

☑ Groundwater vertical profiling for PCE and TCE was conducted in 2009 at a boring located approximately 400 feet upgradient of this property (03MW1059A). PCE and TCE were not detected at concentrations greater than the Maximum Contaminant Level (MCL) of 5 micrograms per liter (µg/L) for each compound (see attached table). At the time of vertical profiling, a maximum TCE concentration of 2.6 µg/L was detected at a depth of 167 ft bgs (-111 ft msl) and PCE was detected at concentrations below the laboratory reporting limit (BRL) of 1 µg/L. Sampling of the monitoring wells at this location since 2009 indicates that concentrations of TCE and PCE have decreased to ND (see attached table). Groundwater sampling at monitoring well cluster 30MW0583A,B,C,D,E, which is located on 539 Currier Rd, indicate that no TCE or PCE was detected at the shallowest (D and E) screens (-9 and +37 ft msl, respectively) when these wells were last sampled in 1997 and 1999. A maximum TCE concentration of 83 µg/L was reported at the B screen in 1997 (mid-screen elevation of -40 ft msl). However, TCE concentrations at this monitoring well had declined to less than 1 µg/L (BRL) by 2004.

☑ Sample results are available for this private well (attached). A sample from this well was collected and submitted for VOC analysis by EPA Method 8260B and total manganese analysis by SW-846 6010B on 28 May 2013. Additionally, samples were collected from private wells at nearby properties (AFCEE Parcel IDs 39677, 39772, 39700, 39910, 39902; see location map) in 2012 and submitted for VOC and manganese analysis.

- No PCE or TCE was reported in the sample collected from 539 Currier Road in 2013 or five nearby private wells that were sampled in 2012. TCE was detected at one location, AFCEE Parcel ID 39902, at a concentration that is less than the laboratory reporting limit of 1 µg/L (BRL).
- No Mn was detected in the sample collected from this private well in May 2013.

WELL DETERMINATION

DETERMINATION: Based on the May 2013 sampling results there is no current risk of exposure to Ashumet Valley plume COC concentrations above applicable standards. This property is located approximately 580 feet north and upgradient of the Ashumet Valley VOC plume boundary; the top of which is at a depth of ~150 ft bgs [-100 ft msl]. The depth of the private well at 539 Currier Road is unknown, but is likely to be shallower in the aquifer than the top of the Ashumet Valley plume. PCE and TCE concentrations at nearby monitoring wells are currently either non-detect or below the laboratory reporting limit of 1 µg/L (BRL) for each of these compounds and concentrations, when present, are expected to continue to decrease. This private well is located approximately 700 feet downgradient of CS-10 southern trench extraction well, 03EW2112, which was installed in 2009 to intercept the CS-10 southern trench lobe. Impacts to this property from the CS-10 southern trench lobe are not anticipated. No Mn was detected in a sample collected from this private well in May 2013. Therefore, intermittent pumping of this well for outdoor irrigation purposes is unlikely to draw in groundwater with PCE and TCE concentrations greater than the MCL or result in an unacceptable exposure risk to total Mn.

PATH FORWARD: No further sampling needed.

SAMPLING NEEDED: ☐ **Yes** ☒ **No**

RE-EVALUATE IN NEXT 5-YEAR REVIEW: ☒ **Yes** ☐ **No**

MMR
MASSACHUSETTS MILITARY RESERVATION

Installation Restoration Program

Air Force Center for Engineering and the Environment

Private Well Verification Form ***Please respond by February 3, 2012***

1) Is your home connected to Municipal water? X Yes ____No ____Don't know

2) Is there a water well(s) located on your property? X Yes ____No ____Don't know
   If **YES**, how many wells are located on your property? 1
   If **NO**, survey complete, please skip to 10) and return form.

RECEIVED
JAN 1_ 2012

3) Is the well water used for?
   - Drinking (indoors) ____Yes X No
   - Other indoor uses (cooking, bathing, clothes washing) ____Yes X No
   - Outdoor uses (gardening, car washing, filling pools) ____Yes X No
   - Other (specify) Run for 1 Hour / yearly
   - Is the well disconnected ____Yes X No ____Don't know

4) Would you allow the Air Force to test your well water if necessary? X Yes ____No
   - (At no cost to you)

5) Has your well ever been tested? ___Yes (elaborate on **back** of this page) ___No X Don't know

6) Do you know the depth of your private well? ____ Yes, the depth is ____________ X No

7) Do you know any other construction details of the well? (Company that installed it, date of installation, and exact location on your property?) ____Yes X No
   - (If yes, please provide additional details on the **back** of this page.)

8) If there is a concern about the safety of your well water, would you allow the Air Force to decommission your well at no cost to you? ____Yes ____No
   - (Involves disconnecting piping and filling in the well casing, at no cost to you)

9) Would you like to keep your well for future use? X Yes ____No

10) Contact information. Name: Ted Handy

Street address: 539 Currier Rd.

Mailing address if different: P.O. Box 931 West Fal Mass 02574

Email: ____________

Phone number (day): 508-495-7381 Phone number (night): 508-563-9294

Cell phone number: ____________ Best time to contact you: 5-6 pm

Homeowner signature: Ted Handy Date: 1/11/12

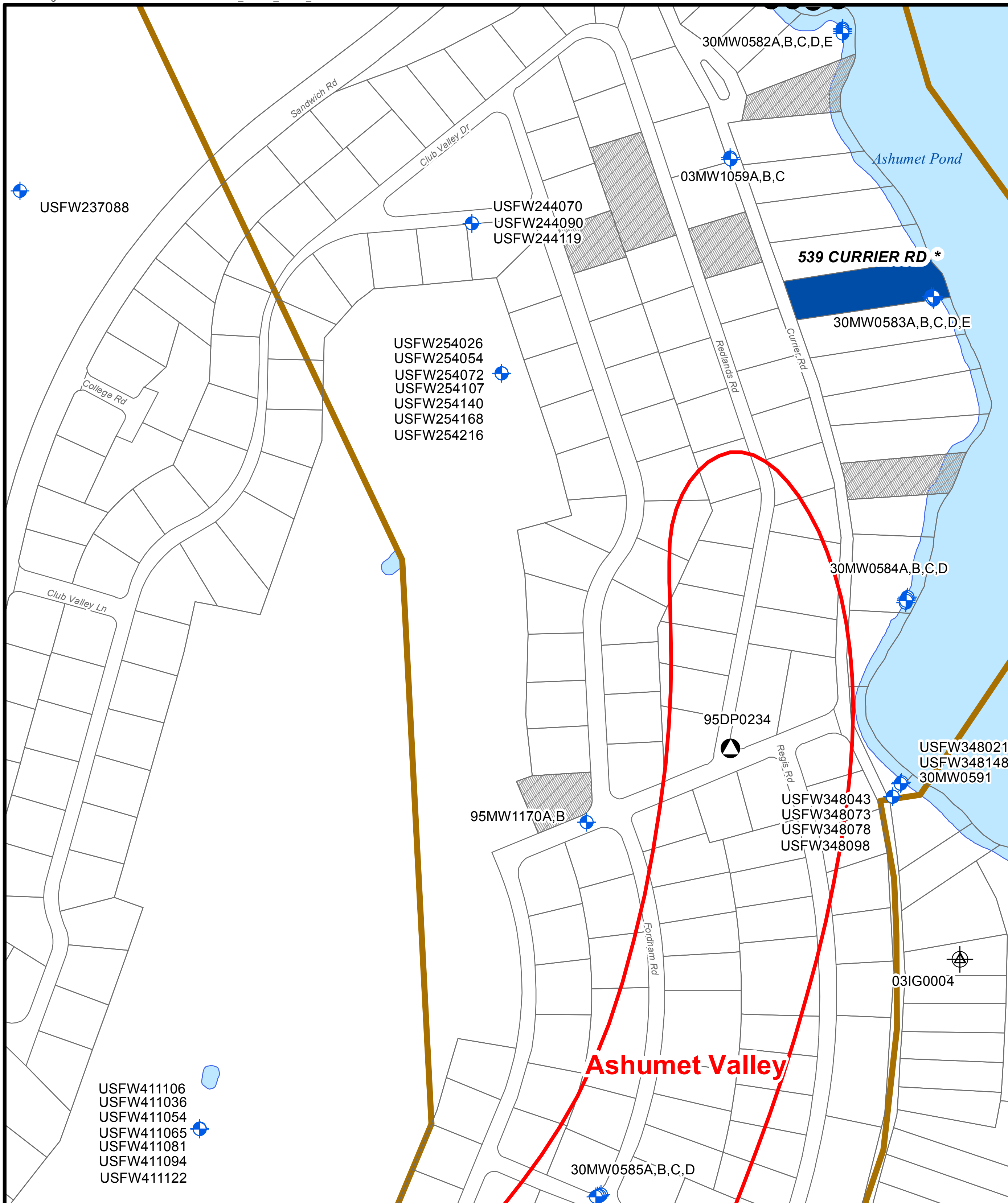
AFCEE APEMS ID#39899

Additional Information

There are test wells just east
of my neighbors property that I
Believe you installed about
10 years ago, Along the shore
of Ashumet Pond

Property Owner: HANDY EDWARD A, APEMS ID# 39899

Path: Y:\Figures\General\LUC\2013\5thYrReview\LUC_13LUC_39899_Currier539.mxd Date: 7/17/2013 Time: 1:16:55 PM User: 1272479611E



Data Source: AFCEC, MMR-AFCEC Data Warehouse

Legend

- Plume Boundary
- LUC Boundary
- Parcel of Interest *
- Private Well Sampled in 2012
- Other Parcel
- Monitoring Well
- Direct Push/Borehole
- Irrigation Well

* Note: Private Well Sampled in 2013

N

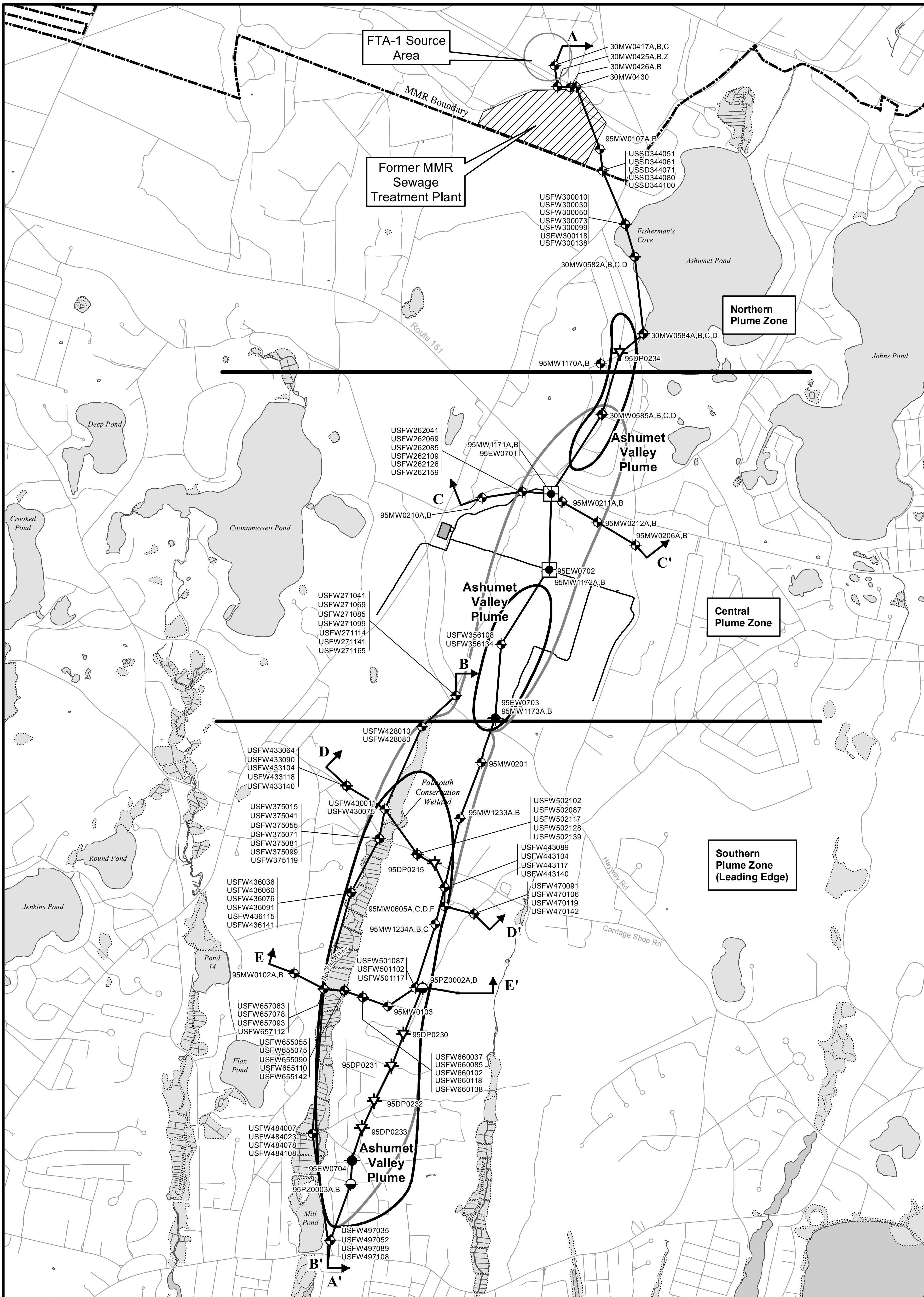
0 190 380 Feet

LOCATION:539 CURRIER RD

AFCEC - Massachusetts Military Reservation

Ashumet Valley Land Use Control

CH2MHILL.



Legend

- Massachusetts Military Reservation Boundary
- ETI System Pipeline and Treatment Plant
- 2007 Plume Boundary
- 2011 Plume Boundary
- Bog/Wetland
- A — A' Location of Cross-section
- Extraction Well (On)
- Extraction Well (Off)
- Monitoring Well
- Piezometer
- Vertical Profiling Location (Direct Push)

Data Source: AFCEE, January 2012, AFCEE - MMR Data Warehouse

N

0 950 1,900 Feet

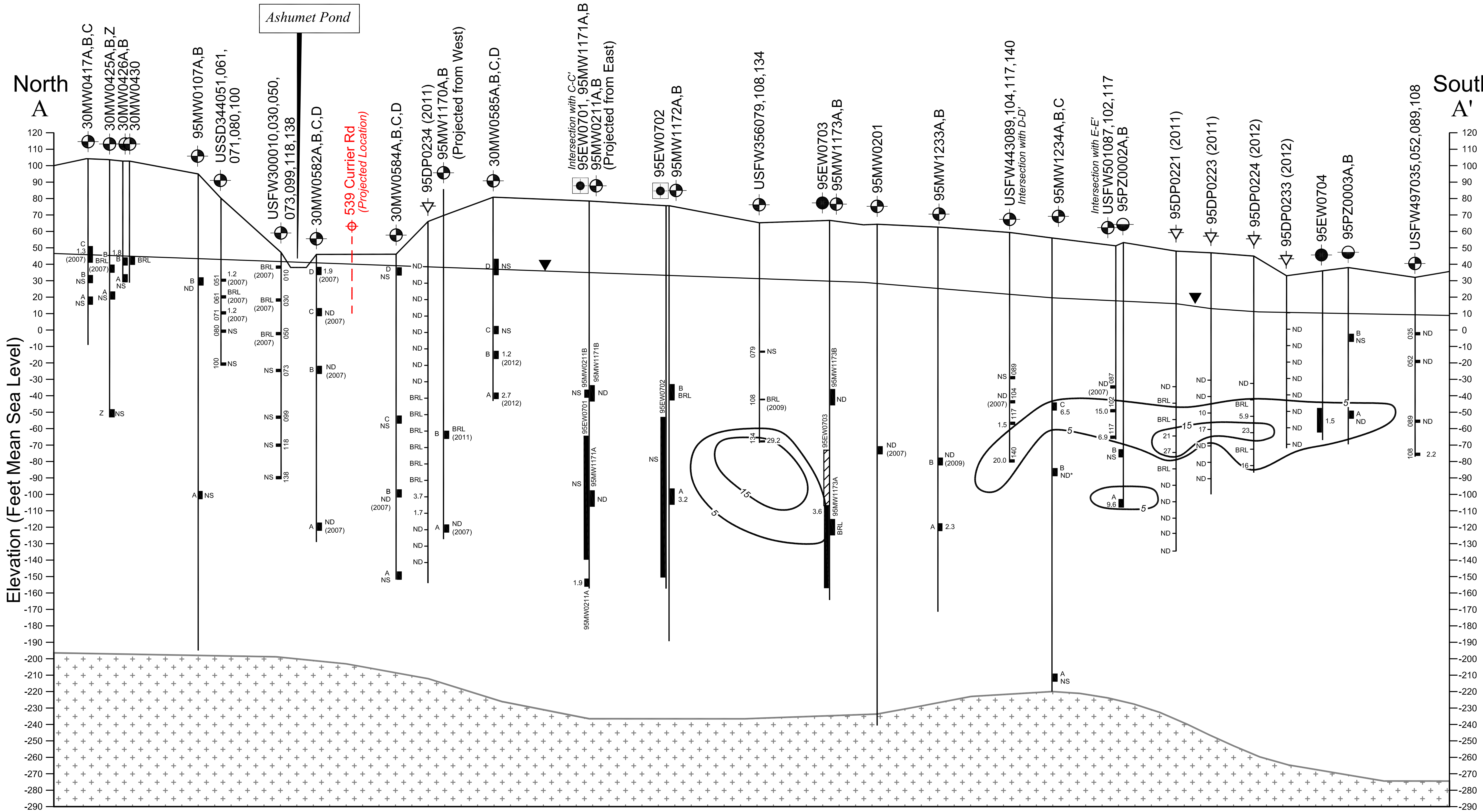
FIGURE 3

ASHUMET VALLEY PLUME AND LOCATION OF CROSS-SECTION LINES

AFCEE - Massachusetts Military Reservation

26 January 2012 Technical Update Meeting

CH2MHILL.



Source: AFCEE, January 2012, MMR-AFCEE Data Warehouse.

Legend

- Monitoring Well
- Extraction Well (On)
- Extraction Well (Off)
- Direct Push Location
- Piezometer
- Water Table
- NS — Not Sampled
- ND — Nondetect
- BRL — Below Reporting Limit
- Private Well (Unknown Depth)
- 5 — 2011 PCE Isoconcentration Contour (Dashed Where Inferred)
- 15 — PCE Results (µg/L)
- A 119 — Well Screen ID
- ND ND — Groundwater Vertical Profile Results (µg/L) (December 2011/January 2012)
- Packered Well Screen
- Bedrock

Note: Data Presented Includes Most Recent Monitoring Results Through December 2010 (Triennial Wells) or August 2011 (Annual Wells) (Unless Otherwise Noted)

* One-time Sampling of 95MW1234B Conducted in October 2011

V: 60
H: 1335
0 Feet

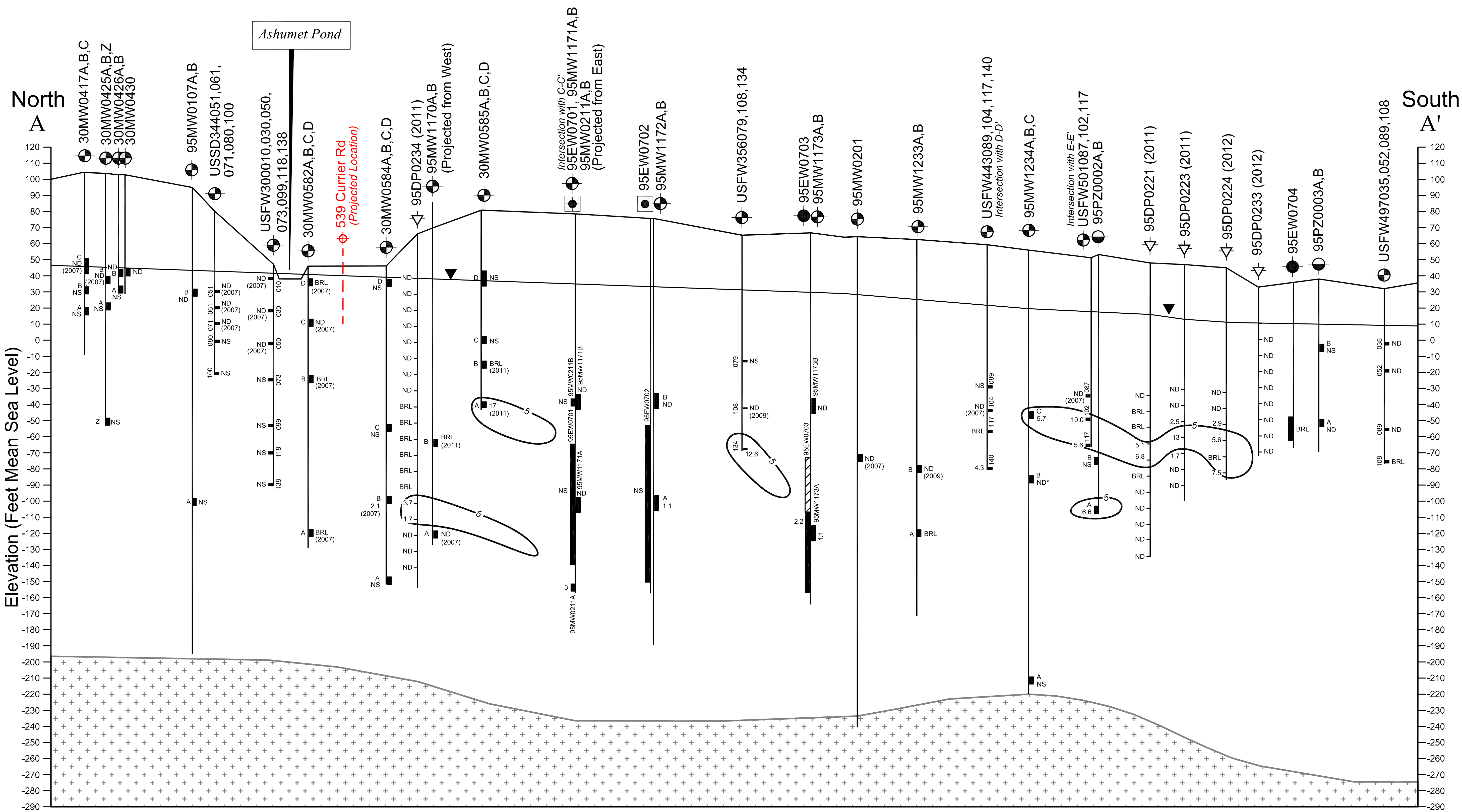
FIGURE 4

ASHUMET VALLEY PCE
CROSS-SECTION A-A'

AFCEE - Massachusetts Military Reservation

26 January 2012 Technical Update Meeting (Modified With Private Well Location)

CH2MHILL.



Legend

Monitoring Well	Piezometer	Private Well (Unknown Depth)	Groundwater Vertical Profile Results (µg/L) (December 2011/January 2012)
Extraction Well (On)	Water Table	2011 TCE Isoconcentration Contour (Dashed Where Inferred)	Packered Well Screen
Extraction Well (Off)	NS Not Sampled	15 PCE Results (µg/L)	Bedrock
Direct Push Location	ND Nondetect	A 119 Well Screen ID	
	BRL Below Reporting Limit		

Source: AFCEE, January 2012, MMR-AFCEE Data Warehouse.

Note: Data Presented Includes Most Recent Monitoring Results Through December 2010 (Triennial Wells) or August 2011 (Annual Wells) (Unless Otherwise Noted)

* One-time Sampling of 95MW1234B Conducted in October 2011

V: 60
H: 1335
0 Feet

FIGURE 5

ASHUMET VALLEY TCE CROSS-SECTION A-A'

AFCEE - Massachusetts Military Reservation

26 January 2012 Technical Update Meeting (Modified With Private Well Location)

CH2MHILL.

Technical Update Meeting - 09 December 2009
Borehole Preliminary Groundwater Screening Results
Boring 03MW1059A (Downgradient of 03EW2112 - Currier Road)

Sample Interval	Date Sampled	Depth TOS (ft bgs)	Depth BOS (ft bgs)	Mid-Depth (ft bgs)	Mid-Depth (ft msl)	TCE (µg/L) MCL = 5 µg/L	PCE (µg/L) MCL = 5 µg/L
A	10/12/09	25	30	27.5	28.5	ND	ND
B	10/13/09	35	40	37.5	18.5	ND	ND
C	10/13/09	45	50	47.5	8.5	ND	ND
D	10/13/09	55	60	57.5	-1.5	ND	ND
E	10/14/09	65	70	67.5	-11.5	ND	ND
F	10/14/09	75	80	77.5	-21.5	ND	ND
G	10/14/09	85	90	87.5	-31.5	ND	ND
H	10/14/09	95	100	97.5	-41.5	ND	ND
I	10/14/09	105	110	107.5	-51.5	BRL	ND
J	10/15/09	115	120	117.5	-61.5	BRL	ND
K	10/15/09	125	130	127.5	-71.5	BRL	ND
L	10/15/09	135	140	137.5	-81.5	ND	ND
M	10/15/09	145	150	147.5	-91.5	BRL	BRL
N	10/16/09	155	160	157.5	-101.5	2.2	BRL
O	10/16/09	165	170	167.5	-111.5	2.6	BRL
P	10/16/09	175	180	177.5	-121.5	BRL	ND
Q	10/16/09	185	190	187.5	-131.5	ND	ND
R	10/19/09	195	200	197.5	-141.5	ND	ND
S	10/19/09	205	210	207.5	-151.5	BRL	ND
T	10/19/09	215	220	217.5	-161.5	ND	ND
U	10/19/09	225	230	227.5	-171.5	ND	ND
V	10/20/09	235	240	237.5	-181.5	ND	ND
W	10/20/09	245	250	247.5	-191.5	ND	ND
X	10/20/09	255	260	257.5	-201.5	NS	NS

Data Source: AFCEE, October 2009, Analytics

Key:

BOS = bottom of sample
BRL = below reporting limit
ft bgs = feet below ground surface
ft msl = feet mean sea level
MCL = Maximum Contaminant Level
ND = not detected
NS = not sampled
PCE = tetrachloroethene
TCE = trichloroethene
TOS = top of sample
µg/L = micrograms per liter

Notes:

Ground surface elevation is approximately 56 ft msl.
03EW2112 screened from 148 to 208 ft bgs (-89.6 to -149.6 ft msl).
Bottom of boring was at 261 ft bgs (-205 ft msl).
Monitoring wells were installed from 205-210 ft bgs (03MW1059A), 165-170 ft bgs (03MW1059B), and 115-120 ft bgs (03MW1059C).

Summary of Groundwater Monitoring Results for PCE and TCE
03MW1059A,B,C

Location	Matrix	Test	Analyte	Depth	Date	Result	DL	RL	Units
03MW1059A	WG	SW8260B	TETRACHLOROETHENE (PCE)	207.3	5/3/2010	ND	0.07	1	µg/L
03MW1059A	WG	SW8260B	TETRACHLOROETHENE (PCE)	207.3	2/16/2011	ND	0.19	1	µg/L
03MW1059A	WG	SW8260B	TETRACHLOROETHENE (PCE)	207.3	11/17/2011	ND	0.19	1	µg/L
03MW1059A	WG	SW8260B	TRICHLOROETHENE (TCE)	207.3	5/3/2010	ND	0.14	1	µg/L
03MW1059A	WG	SW8260B	TRICHLOROETHENE (TCE)	207.3	2/16/2011	ND	0.2	1	µg/L
03MW1059A	WG	SW8260B	TRICHLOROETHENE (TCE)	207.3	11/17/2011	ND	0.2	1	µg/L
03MW1059B	WG	SW8260B	TETRACHLOROETHENE (PCE)	167.35	5/3/2010	BRL	0.07	1	µg/L
03MW1059B	WG	SW8260B	TETRACHLOROETHENE (PCE)	167.35	2/16/2011	ND	0.19	1	µg/L
03MW1059B	WG	SW8260B	TETRACHLOROETHENE (PCE)	167.35	11/17/2011	ND	0.19	1	µg/L
03MW1059B	WG	SW8260B	TRICHLOROETHENE (TCE)	167.35	5/3/2010	1.7	0.14	1	µg/L
03MW1059B	WG	SW8260B	TRICHLOROETHENE (TCE)	167.35	2/16/2011	BRL	0.2	1	µg/L
03MW1059B	WG	SW8260B	TRICHLOROETHENE (TCE)	167.35	11/17/2011	ND	0.2	1	µg/L
03MW1059C	WG	SW8260B	TETRACHLOROETHENE (PCE)	117.4	5/3/2010	ND	0.07	1	µg/L
03MW1059C	WG	SW8260B	TETRACHLOROETHENE (PCE)	117.4	2/16/2011	ND	0.19	1	µg/L
03MW1059C	WG	SW8260B	TETRACHLOROETHENE (PCE)	117.4	11/17/2011	ND	0.19	1	µg/L
03MW1059C	WG	SW8260B	TRICHLOROETHENE (TCE)	117.4	5/3/2010	BRL	0.14	1	µg/L
03MW1059C	WG	SW8260B	TRICHLOROETHENE (TCE)	117.4	2/16/2011	ND	0.2	1	µg/L
03MW1059C	WG	SW8260B	TRICHLOROETHENE (TCE)	117.4	11/17/2011	ND	0.2	1	µg/L

Data Source: AFCEE-MMR Data Warehouse, May 2012

Key:

BRL = below laboratory reporting limit

µg/L = micrograms per liter

DL = detection limit

RL = laboratory reporting limit

ND = non detect

WG = groundwater sample

Summary of Groundwater Monitoring Results for PCE and TCE
30MW0583A,B,C,D,E

Location	Matrix	Test	Analyte	Depth	Date	Result	DL	RL	Units
30MW0583A	WG	CVOL	TETRACHLOROETHENE (PCE)	170.5	8/12/1997	ND	0.41	1	µg/L
30MW0583A	WG	CVOL	TETRACHLOROETHENE (PCE)	170.5	7/12/1999	ND	0.22	1	µg/L
30MW0583A	WG	CVOL	TETRACHLOROETHENE (PCE)	170.5	9/27/1999	ND	0.1	1	µg/L
30MW0583A	WG	CVOL	TETRACHLOROETHENE (PCE)	170.5	1/26/2000	ND	0.1	1	µg/L
30MW0583A	WG	CVOL	TETRACHLOROETHENE (PCE)	170.5	3/27/2000	ND	0.11	1	µg/L
30MW0583A	WG	CVOL	TETRACHLOROETHENE (PCE)	170.5	6/28/2000	ND	0.11	1	µg/L
30MW0583A	WG	CVOL	TETRACHLOROETHENE (PCE)	170.5	9/27/2000	ND	0.11	1	µg/L
30MW0583A	WG	CVOL	TETRACHLOROETHENE (PCE)	170.5	12/21/2000	ND	0.11	1	µg/L
30MW0583A	WG	CVOL	TETRACHLOROETHENE (PCE)	170.5	4/3/2001	ND	0.11	1	µg/L
30MW0583A	WG	CVOL	TETRACHLOROETHENE (PCE)	170.5	5/29/2001	ND	0.11	1	µg/L
30MW0583A	WG	SW8260	TETRACHLOROETHENE (PCE)	170.5	9/11/2001	ND	0.161	1	µg/L
30MW0583A	WG	SW8260	TETRACHLOROETHENE (PCE)	170.5	4/5/2002	ND	0.146	1	µg/L
30MW0583A	WG	SW8260	TETRACHLOROETHENE (PCE)	170.5	10/29/2002	ND	0.146	1	µg/L
30MW0583A	WG	SW8260B	TETRACHLOROETHENE (PCE)	170.5	4/14/2003	BRL	0.137	1	µg/L
30MW0583A	WG	SW8260B	TETRACHLOROETHENE (PCE)	170.5	10/24/2003	ND	0.421	1	µg/L
30MW0583A	WG	SW8260B	TETRACHLOROETHENE (PCE)	170.5	5/13/2004	ND	1	1	µg/L
30MW0583A	WG	SW8260B	TETRACHLOROETHENE (PCE)	170.5	11/10/2004	BRL	0.18	1	µg/L
30MW0583A	WG	CVOL	TRICHLOROETHENE (TCE)	170.5	8/12/1997	ND	0.62	1	µg/L
30MW0583A	WG	CVOL	TRICHLOROETHENE (TCE)	170.5	7/12/1999	2.65	0.35	1	µg/L
30MW0583A	WG	CVOL	TRICHLOROETHENE (TCE)	170.5	9/27/1999	1.7	0.12	1	µg/L
30MW0583A	WG	CVOL	TRICHLOROETHENE (TCE)	170.5	1/26/2000	2	0.12	1	µg/L
30MW0583A	WG	CVOL	TRICHLOROETHENE (TCE)	170.5	3/27/2000	1.8	0.09	1	µg/L
30MW0583A	WG	CVOL	TRICHLOROETHENE (TCE)	170.5	6/28/2000	1.9	0.09	1	µg/L
30MW0583A	WG	CVOL	TRICHLOROETHENE (TCE)	170.5	9/27/2000	2.2	0.09	1	µg/L
30MW0583A	WG	CVOL	TRICHLOROETHENE (TCE)	170.5	12/21/2000	2.1	0.09	1	µg/L
30MW0583A	WG	CVOL	TRICHLOROETHENE (TCE)	170.5	4/3/2001	2.4	0.09	1	µg/L
30MW0583A	WG	CVOL	TRICHLOROETHENE (TCE)	170.5	5/29/2001	2.3	0.09	1	µg/L
30MW0583A	WG	SW8260	TRICHLOROETHENE (TCE)	170.5	9/11/2001	2.3	0.2	1	µg/L
30MW0583A	WG	SW8260	TRICHLOROETHENE (TCE)	170.5	4/5/2002	2.51	0.138	1	µg/L
30MW0583A	WG	SW8260	TRICHLOROETHENE (TCE)	170.5	10/29/2002	2.1	0.138	1	µg/L
30MW0583A	WG	SW8260B	TRICHLOROETHENE (TCE)	170.5	4/14/2003	2.28	0.203	1	µg/L
30MW0583A	WG	SW8260B	TRICHLOROETHENE (TCE)	170.5	10/24/2003	3	0.241	1	µg/L
30MW0583A	WG	SW8260B	TRICHLOROETHENE (TCE)	170.5	5/13/2004	1.8	0.14	1	µg/L
30MW0583A	WG	SW8260B	TRICHLOROETHENE (TCE)	170.5	11/10/2004	2.5	0.11	1	µg/L
30MW0583B	WG	CVOL	TETRACHLOROETHENE (PCE)	135.5	8/12/1997	ND	0.41	5	µg/L
30MW0583B	WG	CVOL	TETRACHLOROETHENE (PCE)	135.5	7/12/1999	1.3	0.22	1	µg/L
30MW0583B	WG	CVOL	TETRACHLOROETHENE (PCE)	135.5	9/27/1999	ND	1	10	µg/L
30MW0583B	WG	CVOL	TETRACHLOROETHENE (PCE)	135.5	1/26/2000	ND	0.2	2	µg/L
30MW0583B	WG	CVOL	TETRACHLOROETHENE (PCE)	135.5	3/27/2000	ND	0.11	1	µg/L
30MW0583B	WG	CVOL	TETRACHLOROETHENE (PCE)	135.5	6/28/2000	ND	0.22	2	µg/L
30MW0583B	WG	CVOL	TETRACHLOROETHENE (PCE)	135.5	9/27/2000	ND	0.44	4	µg/L
30MW0583B	WG	CVOL	TETRACHLOROETHENE (PCE)	135.5	12/21/2000	ND	0.55	5	µg/L
30MW0583B	WG	CVOL	TETRACHLOROETHENE (PCE)	135.5	4/3/2001	BRL	0.44	4	µg/L
30MW0583B	WG	CVOL	TETRACHLOROETHENE (PCE)	135.5	5/29/2001	BRL	0.44	4	µg/L
30MW0583B	WG	SW8260	TETRACHLOROETHENE (PCE)	135.5	9/12/2001	BRL	0.161	1	µg/L
30MW0583B	WG	SW8260	TETRACHLOROETHENE (PCE)	135.5	4/5/2002	1.51	0.146	1	µg/L
30MW0583B	WG	SW8260	TETRACHLOROETHENE (PCE)	135.5	10/29/2002	1.6	0.146	1	µg/L
30MW0583B	WG	SW8260B	TETRACHLOROETHENE (PCE)	135.5	4/14/2003	1.48	0.137	1	µg/L
30MW0583B	WG	SW8260B	TETRACHLOROETHENE (PCE)	135.5	10/24/2003	BRL	0.421	1	µg/L
30MW0583B	WG	SW8260B	TETRACHLOROETHENE (PCE)	135.5	5/13/2004	1.3	0.16	1	µg/L
30MW0583B	WG	SW8260B	TETRACHLOROETHENE (PCE)	135.5	11/10/2004	1.1	0.18	1	µg/L
30MW0583B	WG	CVOL	TRICHLOROETHENE (TCE)	135.5	8/12/1997	83	0.62	5	µg/L
30MW0583B	WG	CVOL	TRICHLOROETHENE (TCE)	135.5	7/12/1999	18.4	0.35	1	µg/L
30MW0583B	WG	CVOL	TRICHLOROETHENE (TCE)	135.5	9/27/1999	BRL	1.2	10	µg/L
30MW0583B	WG	CVOL	TRICHLOROETHENE (TCE)	135.5	1/26/2000	1.9	0.24	2	µg/L
30MW0583B	WG	CVOL	TRICHLOROETHENE (TCE)	135.5	3/27/2000	ND	0.09	1	µg/L
30MW0583B	WG	CVOL	TRICHLOROETHENE (TCE)	135.5	6/28/2000	ND	0.18	2	µg/L
30MW0583B	WG	CVOL	TRICHLOROETHENE (TCE)	135.5	9/27/2000	3.9	0.36	4	µg/L
30MW0583B	WG	CVOL	TRICHLOROETHENE (TCE)	135.5	12/21/2000	10	0.45	5	µg/L
30MW0583B	WG	CVOL	TRICHLOROETHENE (TCE)	135.5	4/3/2001	BRL	0.36	4	µg/L
30MW0583B	WG	CVOL	TRICHLOROETHENE (TCE)	135.5	5/29/2001	BRL	0.36	4	µg/L

Summary of Groundwater Monitoring Results for PCE and TCE
30MW0583A,B,C,D,E

Location	Matrix	Test	Analyte	Depth	Date	Result	DL	RL	Units
30MW0583B	WG	SW8260	TRICHLOROETHENE (TCE)	135.5	9/12/2001	2.73	0.2	1	µg/L
30MW0583B	WG	SW8260	TRICHLOROETHENE (TCE)	135.5	4/5/2002	BRL	0.138	1	µg/L
30MW0583B	WG	SW8260	TRICHLOROETHENE (TCE)	135.5	10/29/2002	BRL	0.138	1	µg/L
30MW0583B	WG	SW8260B	TRICHLOROETHENE (TCE)	135.5	4/14/2003	BRL	0.203	1	µg/L
30MW0583B	WG	SW8260B	TRICHLOROETHENE (TCE)	135.5	10/24/2003	1.7	0.241	1	µg/L
30MW0583B	WG	SW8260B	TRICHLOROETHENE (TCE)	135.5	5/13/2004	BRL	0.14	1	µg/L
30MW0583B	WG	SW8260B	TRICHLOROETHENE (TCE)	135.5	11/10/2004	BRL	0.11	1	µg/L
30MW0583C	WG	CVOL	TETRACHLOROETHENE (PCE)	86.5	8/12/1997	6.6	0.41	2	µg/L
30MW0583C	WG	CVOL	TETRACHLOROETHENE (PCE)	86.5	7/12/1999	ND	0.22	1	µg/L
30MW0583C	WG	CVOL	TETRACHLOROETHENE (PCE)	86.5	9/27/1999	ND	0.1	1	µg/L
30MW0583C	WG	CVOL	TETRACHLOROETHENE (PCE)	86.5	1/26/2000	ND	0.1	1	µg/L
30MW0583C	WG	CVOL	TETRACHLOROETHENE (PCE)	86.5	3/27/2000	ND	0.11	1	µg/L
30MW0583C	WG	CVOL	TETRACHLOROETHENE (PCE)	86.5	6/28/2000	ND	0.11	1	µg/L
30MW0583C	WG	CVOL	TETRACHLOROETHENE (PCE)	86.5	9/27/2000	ND	0.11	1	µg/L
30MW0583C	WG	CVOL	TETRACHLOROETHENE (PCE)	86.5	12/21/2000	ND	0.11	1	µg/L
30MW0583C	WG	CVOL	TETRACHLOROETHENE (PCE)	86.5	4/3/2001	BRL	0.11	1	µg/L
30MW0583C	WG	CVOL	TETRACHLOROETHENE (PCE)	86.5	5/29/2001	BRL	0.22	2	µg/L
30MW0583C	WG	CVOL	TETRACHLOROETHENE (PCE)	86.5	10/1/2001	BRL	0.26	2	µg/L
30MW0583C	WG	SW8260	TETRACHLOROETHENE (PCE)	86.5	4/5/2002	BRL	0.146	1	µg/L
30MW0583C	WG	SW8260	TETRACHLOROETHENE (PCE)	86.5	10/29/2002	1.05	0.146	1	µg/L
30MW0583C	WG	SW8260B	TETRACHLOROETHENE (PCE)	86.5	4/14/2003	2.53	0.137	1	µg/L
30MW0583C	WG	SW8260B	TETRACHLOROETHENE (PCE)	86.5	10/24/2003	BRL	0.421	1	µg/L
30MW0583C	WG	SW8260B	TETRACHLOROETHENE (PCE)	86.5	5/13/2004	1.3	0.16	1	µg/L
30MW0583C	WG	SW8260B	TETRACHLOROETHENE (PCE)	86.5	11/10/2004	BRL	0.18	1	µg/L
30MW0583C	WG	SW8260B	TETRACHLOROETHENE (PCE)	86.5	11/10/2004	BRL	0.18	1	µg/L
30MW0583C	WG	CVOL	TRICHLOROETHENE (TCE)	86.5	8/12/1997	11	0.62	2	µg/L
30MW0583C	WG	CVOL	TRICHLOROETHENE (TCE)	86.5	7/12/1999	ND	0.35	1	µg/L
30MW0583C	WG	CVOL	TRICHLOROETHENE (TCE)	86.5	9/27/1999	ND	0.12	1	µg/L
30MW0583C	WG	CVOL	TRICHLOROETHENE (TCE)	86.5	1/26/2000	ND	0.12	1	µg/L
30MW0583C	WG	CVOL	TRICHLOROETHENE (TCE)	86.5	3/27/2000	ND	0.09	1	µg/L
30MW0583C	WG	CVOL	TRICHLOROETHENE (TCE)	86.5	6/28/2000	ND	0.09	1	µg/L
30MW0583C	WG	CVOL	TRICHLOROETHENE (TCE)	86.5	9/27/2000	ND	0.09	1	µg/L
30MW0583C	WG	CVOL	TRICHLOROETHENE (TCE)	86.5	12/21/2000	ND	0.09	1	µg/L
30MW0583C	WG	CVOL	TRICHLOROETHENE (TCE)	86.5	4/3/2001	BRL	0.09	1	µg/L
30MW0583C	WG	CVOL	TRICHLOROETHENE (TCE)	86.5	5/29/2001	BRL	0.18	2	µg/L
30MW0583C	WG	CVOL	TRICHLOROETHENE (TCE)	86.5	10/1/2001	ND	0.3	2	µg/L
30MW0583C	WG	SW8260	TRICHLOROETHENE (TCE)	86.5	4/5/2002	BRL	0.138	1	µg/L
30MW0583C	WG	SW8260	TRICHLOROETHENE (TCE)	86.5	10/29/2002	BRL	0.138	1	µg/L
30MW0583C	WG	SW8260B	TRICHLOROETHENE (TCE)	86.5	4/14/2003	BRL	0.203	1	µg/L
30MW0583C	WG	SW8260B	TRICHLOROETHENE (TCE)	86.5	10/24/2003	BRL	0.24	1	µg/L
30MW0583C	WG	SW8260B	TRICHLOROETHENE (TCE)	86.5	5/13/2004	BRL	0.14	1	µg/L
30MW0583C	WG	SW8260B	TRICHLOROETHENE (TCE)	86.5	11/10/2004	ND	0.11	1	µg/L
30MW0583C	WG	SW8260B	TRICHLOROETHENE (TCE)	86.5	11/10/2004	ND	0.11	1	µg/L
30MW0583D	WG	CVOL	TETRACHLOROETHENE (PCE)	55.5	8/13/1997	ND	0.41	1	µg/L
30MW0583D	WG	CVOL	TETRACHLOROETHENE (PCE)	55.5	7/12/1999	ND	0.22	1	µg/L
30MW0583D	WG	CVOL	TRICHLOROETHENE (TCE)	55.5	8/13/1997	ND	0.62	1	µg/L
30MW0583D	WG	CVOL	TRICHLOROETHENE (TCE)	55.5	7/12/1999	ND	0.35	1	µg/L
30MW0583E	WG	CVOL	TETRACHLOROETHENE (PCE)	10.5	8/13/1997	ND	0.41	1	µg/L
30MW0583E	WG	CVOL	TETRACHLOROETHENE (PCE)	10.5	7/12/1999	ND	0.22	1	µg/L
30MW0583E	WG	CVOL	TRICHLOROETHENE (TCE)	10.5	8/13/1997	ND	0.62	1	µg/L
30MW0583E	WG	CVOL	TRICHLOROETHENE (TCE)	10.5	7/12/1999	ND	0.35	1	µg/L

Data Source: AFCEE-MMR Data Warehouse, May 2012

Key:

BRL = below laboratory reporting limit   µg/L = micrograms per liter

DL = detection limit   RL = laboratory reporting limit

ND = non detect   WG = groundwater sample

Summary of Groundwater Monitoring Results for Manganese
RS0539CURR

Location	Matrix	Test	Analyte	Date	Result	DL	RL	Units
RS0539CURR	WG	SW6010B	MANGANESE	5/28/2013	ND	2.8	15	µg/L

Data Source: AFCEC-MMR Data Warehouse, July 2013

Key:

DL = detection limit

ND = non detect

RL = reporting limit

WG = groundwater

µg/L = micrograms per liter

analytics environmental laboratory LLC

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Mr. Doug Scott
CH2M Hill
1748 West Truck Road/Otis ANG Base
Buzzards Bay MA 02542

May 31, 2013

SAMPLE DATA

Lab Sample ID:	75634-1
Matrix:	Aqueous
Percent Solid:	N/A
Dilution Factor:	1
Collection Date:	05/28/13
Lab Receipt Date:	05/30/13
Analysis Date:	05/30/13

CLIENT SAMPLE ID

Project Name:	MMR 2013/06 LUC CS-10, CS-21, AV
Project Number:	437075.05.07.18
Field Sample ID:	CHPE0539CU-O0513

ANALYTICAL RESULTS VOLATILE ORGANICS

COMPOUND	Detection Limit µg/L	Quantitation Limit µg/L	Result µg/L	COMPOUND	Detection Limit µg/L	Quantitation Limit µg/L	Result µg/L
1,1,1-Trichloroethane	0.18	1.0	U	Toluene	0.20	1.0	U
1,1-Dichloroethane	0.20	1.0	U	trans-1,2-Dichloroethene	0.20	1.0	U
1,2,4-Trichlorobenzene	0.21	1.0	U	trans-1,3-Dichloropropene	0.10	1.0	U
1,2-Dibromo-3-chloropropane	0.50	1.0	U	Trichloroethene	0.20	1.0	U
1,2-Dichlorobenzene	0.16	1.0	U	1,1,2,2-Tetrachloroethane	0.13	1.0	U
1,3-Dichlorobenzene	0.20	1.0	U	1,1,2-Trichloroethane	0.11	1.0	U
1,4-Dichlorobenzene	0.19	1.0	U	1,1-Dichloroethene	0.13	1.0	U
Benzene	0.20	1.0	U	1,2-Dibromoethane	0.15	1.0	U
Bromochloromethane	0.20	1.0	U	1,2-Dichloroethane	0.50	1.0	U
Chlorobenzene	0.17	1.0	U	1,2-Dichloropropane	0.50	1.0	U
Chloroform	0.20	1.0	U	Bromodichloromethane	0.15	1.0	U
cis-1,2-Dichloroethene	0.20	1.0	U	Bromoform	0.12	1.0	U
cis-1,3-Dichloropropene	0.10	1.0	U	Bromomethane	0.50	1.0	U
Ethylbenzene	0.20	1.0	U	Carbon Tetrachloride	0.20	1.0	U
Methylene Chloride	1.0	2.0	U	Chloroethane	0.50	1.0	U
o-Xylene	0.20	1.0	U	Chloromethane	0.20	1.0	U
m,p-Xylene	0.40	1.0	U	Dibromochloromethane	0.15	1.0	U
Styrene	0.20	1.0	U	Methyl-tert-butyl ether (MTBE)	0.20	1.0	U
Tetrachloroethene	0.19	1.0	U	Vinyl chloride	0.20	1.0	U

Surrogate Standard Recovery

Bromofluorobenzene 101% d4-1,2-Dichloroethane 105% d8-Toluene 99%

U=Undetected J=Estimated E=Exceeds Calibration Range B=Detected in Blank

METHODOLOGY: Sample analysis was conducted according to: Test Methods for Evaluating Solid Waste, SW-846 Method 8260B.

COMMENTS:

set2ColumnMDLandDL:Res(0):Rec(0) - CH2MMR(BI)-AQ-Short(noTMBs)_7_27_10

Authorized signature

WELL DETERMINATION

ADDRESS: 533 Currier Road, Falmouth MA

APEMS ID: 39900

WELL STATUS: ACTIVE

WELL USE: Outdoor uses

SUMMARY: According to the property owner response (attached), this residence is connected to the Falmouth municipal water supply. This residence receives a water bill from the Town of Falmouth. However, there is a private well located on this property that is used for outdoor purposes. The total depth of this well is unknown. Depth to water in this area is approximately 12 ft bgs (+45 ft msl). This property is located along the southern border of the Ashumet Valley LTM area, approximately 580 feet north and outside of the Ashumet Valley Plume boundary.

DATA REVIEW:

☑ SPEIM monitoring data are available in the vicinity of this well [see attached map and cross sections].

- 03MW1059A,B,C [vertical profiling and monitoring data; tables attached]
- 30MW0583A,B,C,D,E [monitoring data; table attached]
- Water table elevation is approximately 45 ft msl.

☑ Groundwater vertical profiling for PCE and TCE was conducted in 2009 at a boring located approximately 420 feet upgradient of this property (03MW1059A). PCE and TCE were not detected at concentrations greater than the Maximum Contaminant Level (MCL) of 5 micrograms per liter (µg/L) for each compound (see attached table). At the time of vertical profiling, a maximum TCE concentration of 2.6 µg/L was detected at a depth of 167 ft bgs (-111 ft msl) and PCE was detected at concentrations below the laboratory reporting limit (BRL) of 1 µg/L. Sampling of the monitoring wells at this location since 2009 indicates concentrations of TCE and PCE have decreased to ND (see attached table). Groundwater sampling at monitoring well cluster 30MW0583A,B,C,D,E, which is located on 533 Currier Rd, indicates that no TCE or PCE was detected at the shallowest (D and E) screens (-9 and +37 ft msl, respectively) when these wells were last sampled in 1997 and 1999. A maximum TCE concentration of 83 µg/L was reported at the B screen in 1997 (mid-screen elevation of -40 ft msl). However, TCE concentrations at this monitoring well had declined to less than 1 µg/L (BRL) by 2004.

☑ Sample results are available for this private well (attached). A sample from this well was collected and submitted for VOC analysis by EPA Method 8260B and total manganese analysis by SW-846 6010B on 30 May 2013. Additionally, samples were collected from private wells at nearby properties (AFCEE Parcel IDs 39677, 39772, 39700, 39910, 39902; see location map) in 2012 and submitted for VOC and manganese analysis.

- No PCE or TCE was reported in the sample collected from 533 Currier Road in 2013 or five nearby private wells that were sampled in 2012. TCE was detected at one location, AFCEE Parcel ID 39902, at a concentration that is less than the laboratory reporting limit of 1 µg/L (BRL).
- No Mn was detected in the sample collected from this private well.

WELL DETERMINATION

DETERMINATION: Based on the May 2013 sampling results there is no current risk of exposure to Ashumet Valley plume COC concentrations above applicable standards. This property is located approximately 580 feet north and upgradient of the Ashumet Valley VOC plume boundary; the top of which is at a depth of ~150 ft bgs [-100 ft msl]. The depth of the private well at 533 Currier Road is unknown, but is likely to be shallower in the aquifer than the top of the Ashumet Valley plume. PCE and TCE concentrations at nearby monitoring wells are currently either non-detect or below the laboratory reporting limit of 1 µg/L (BRL) for each of these compounds and concentrations, when present, are expected to continue to decrease. This private well is located approximately 720 feet downgradient of CS-10 southern trench extraction well, 03EW2112, which was installed in 2009 to intercept the CS-10 southern trench lobe. Impacts to this property from the CS-10 southern trench lobe are not anticipated. No Mn was detected in the sample collected from this well in May 2013. Therefore, intermittent pumping of this well for outdoor irrigation purposes is unlikely to draw in groundwater with PCE and TCE concentrations greater than the MCL or result in an unacceptable exposure risk to total Mn.

PATH FORWARD: No further sampling needed.

SAMPLING NEEDED: ☐ **Yes** ☒ **No**

RE-EVALUATE IN NEXT 5-YEAR REVIEW: ☒ **Yes** ☐ **No**

AFCEC MMR Land Use Controls
Parcel Summary

Report Produced: 7/9/2013

Name: Westcott, David

Plume: Ashumet Valley

Telephone No.

Mailing Address

AFCEE Plume: Ashumet Valley

Mailing PO:

Mailing Street: 533 CURRIER RD

Mailing City: EAST FALMOUTH

Mailing State: MA

Mailing ZIP: 02536

Town Numbers

Map: 09 *Section:* 01 *Parcel:* 007 *Lot:* 006

Residential Well Notes: 02-02-2013: Well has been reactivated per email response. Used for outdoor watering.

Irrigation Well Notes:

Parcel Address

APEMS ID: 39900

Parcel Street: 533 CURRIER RD

Parcel City: Falmouth

Parcel State:

Parcel ZIP:

Town Water Notes:

Other Notes:

☐ Checked if the parcel respond to the state's 5-Star survey.

☐ Checked if AFCEE has been in contact with the parcel and no contact is needed.

Initial Mailing Sent? ☐	*Date Sent:*	*Date Returned:*	1/18/2012
Second Mailing Sent? ☐	*Date Sent:*	*Date Returned:*	
Third Mailing Sent? ☐	*Date Sent:*	*Date Returned:*	
Contacted by Phone? ☐	*Date Contacted:*	*Contact Note:*	
Contacted by Email? ☐	*Email Date:*	*Date Returned::*	
Contacted In-Person? ☑	*Date Contacted:* 2/22/2012		
Field Visit Performed? ☑	*Field Visit Date:* 2/22/2012	*Field Visit Note:*	Well exists but is non-functional per owner during field visit.

Other Contact Notes: Changed owner per well verification form and Town of Falmouth Assessor records.

Wells associated with this parcel:

LocID

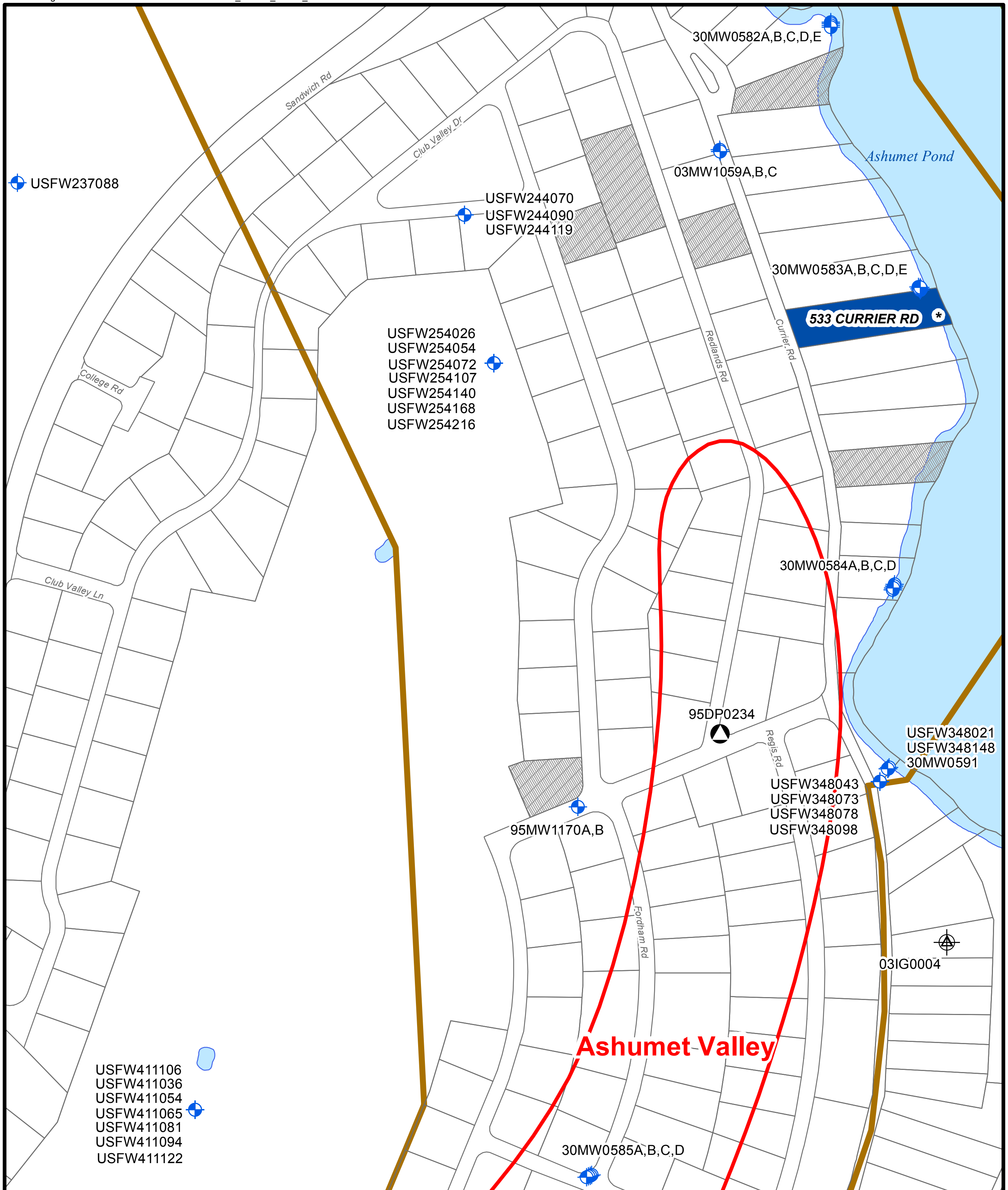
Functional? ☑ ***Depth*** 0 ***Decomissioned?*** ☐ ***Well Deemed Safe?*** ☐

Non-Functional? ☐ ***Pump Rate*** 0 ***Decomission Offer Made?*** ☐ ***Date:***

Other Status? ***Decomission Offer Received?*** ☐

Originating Source:

Path: Y:\Figures\General\LUC\2013\5thYrReview\LUC_13LUC_39900_Currier533.mxd Date: 7/17/2013 Time: 1:16:47 PM User: 1272479611E



Data Source: AFCEC, MMR-AFCEC Data Warehouse

Legend

- Plume Boundary
- LUC Boundary
- Parcel of Interest *
- Private Well Sampled in 2012
- Other Parcel
- Monitoring Well
- Direct Push/Borehole
- Irrigation Well

* Note: Private Well Sampled in 2013

N

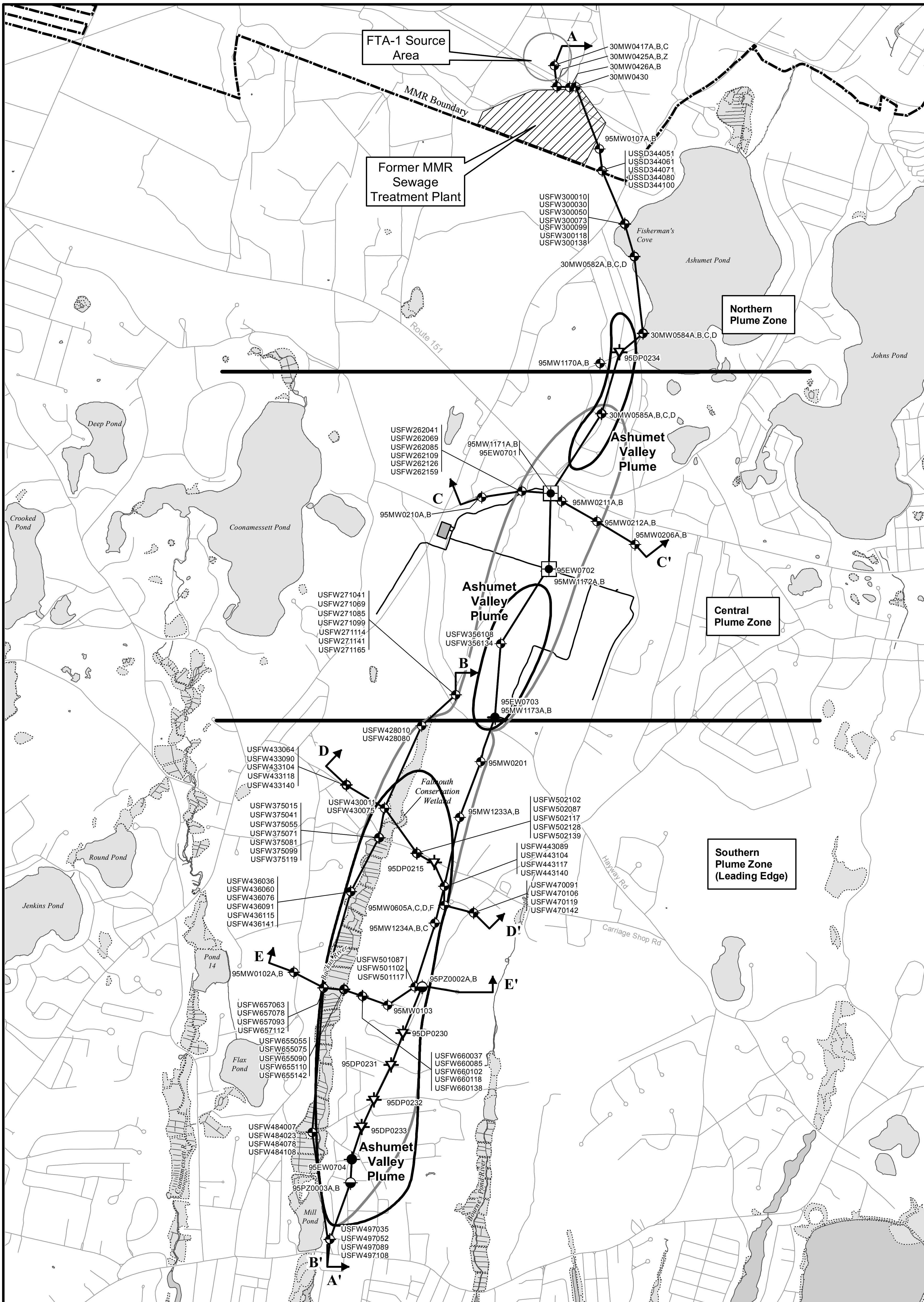
0 190 380 Feet

LOCATION:533 CURRIER RD

AFCEC - Massachusetts Military Reservation

Ashumet Valley Land Use Control

CH2MHILL.



Legend

- Massachusetts Military Reservation Boundary
- ETI System Pipeline and Treatment Plant
- 2007 Plume Boundary
- 2011 Plume Boundary
- Bog/Wetland

Data Source: AFCEE, January 2012, AFCEE - MMR Data Warehouse

A — A' Location of Cross-section
- Extraction Well (On)
- Extraction Well (Off)
- Monitoring Well
- Piezometer
- Vertical Profiling Location (Direct Push)

N

0 950 1,900 Feet

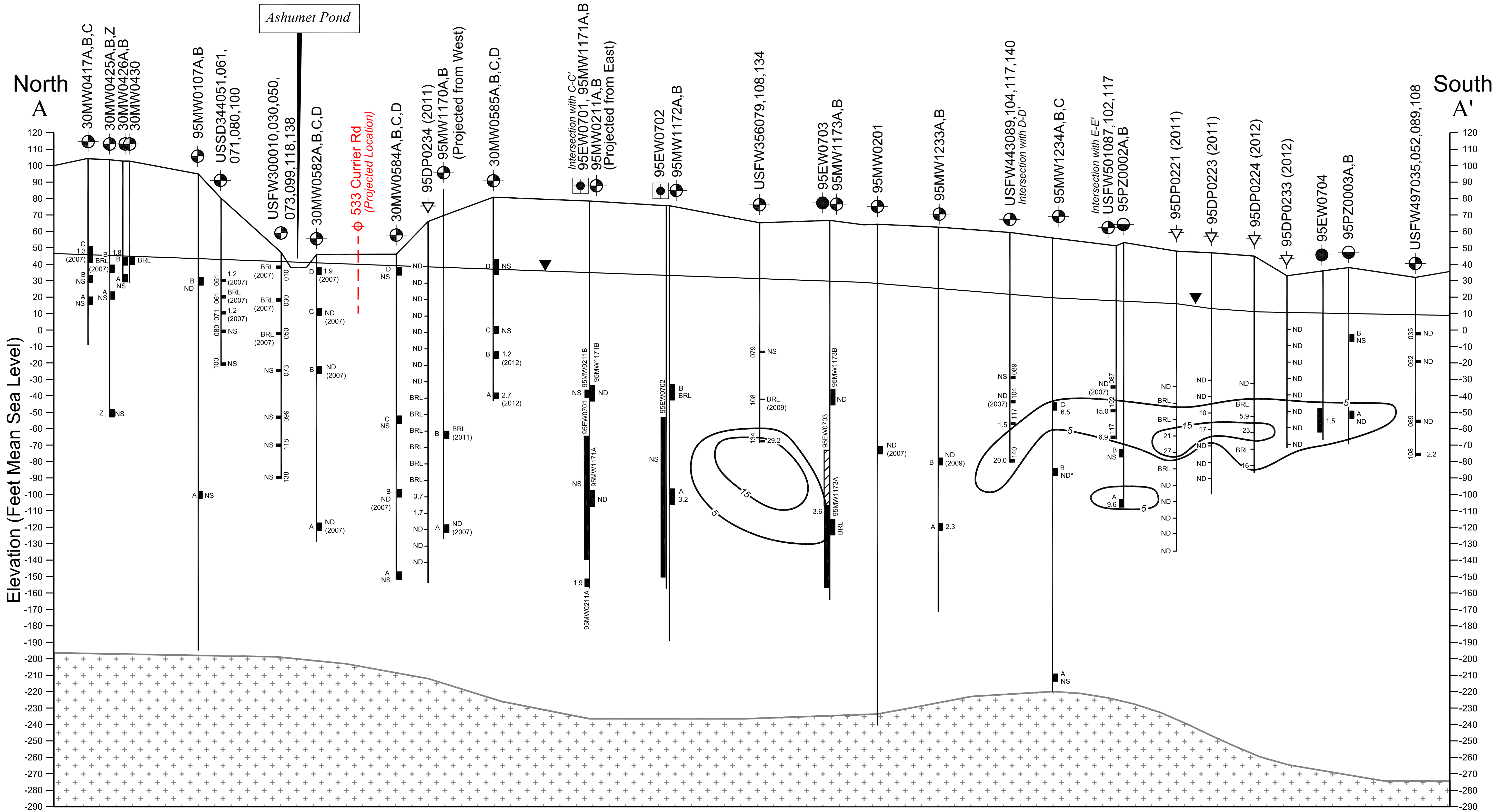
FIGURE 3

ASHUMET VALLEY PLUME AND LOCATION OF CROSS-SECTION LINES

AFCEE - Massachusetts Military Reservation

26 January 2012 Technical Update Meeting

CH2MHILL.



Source: AFCEE, January 2012, MMR-AFCEE Data Warehouse.

Legend

- Monitoring Well
- Extraction Well (On)
- Extraction Well (Off)
- Direct Push Location
- Piezometer
- Water Table
- NS Not Sampled
- ND Nondetect
- BRL Below Reporting Limit
- Private Well (Unknown Depth)
- 5 2011 PCE Isoconcentration Contour (Dashed Where Inferred)
- 15 PCE Results (µg/L)
- A 119 Well Screen ID
- ND ND Groundwater Vertical Profile Results (µg/L) (December 2011/January 2012)
- Packered Well Screen
- Bedrock

Note: Data Presented Includes Most Recent Monitoring Results Through December 2010 (Triennial Wells) or August 2011 (Annual Wells) (Unless Otherwise Noted)

* One-time Sampling of 95MW1234B Conducted in October 2011

0 Feet V: 60 H: 1335

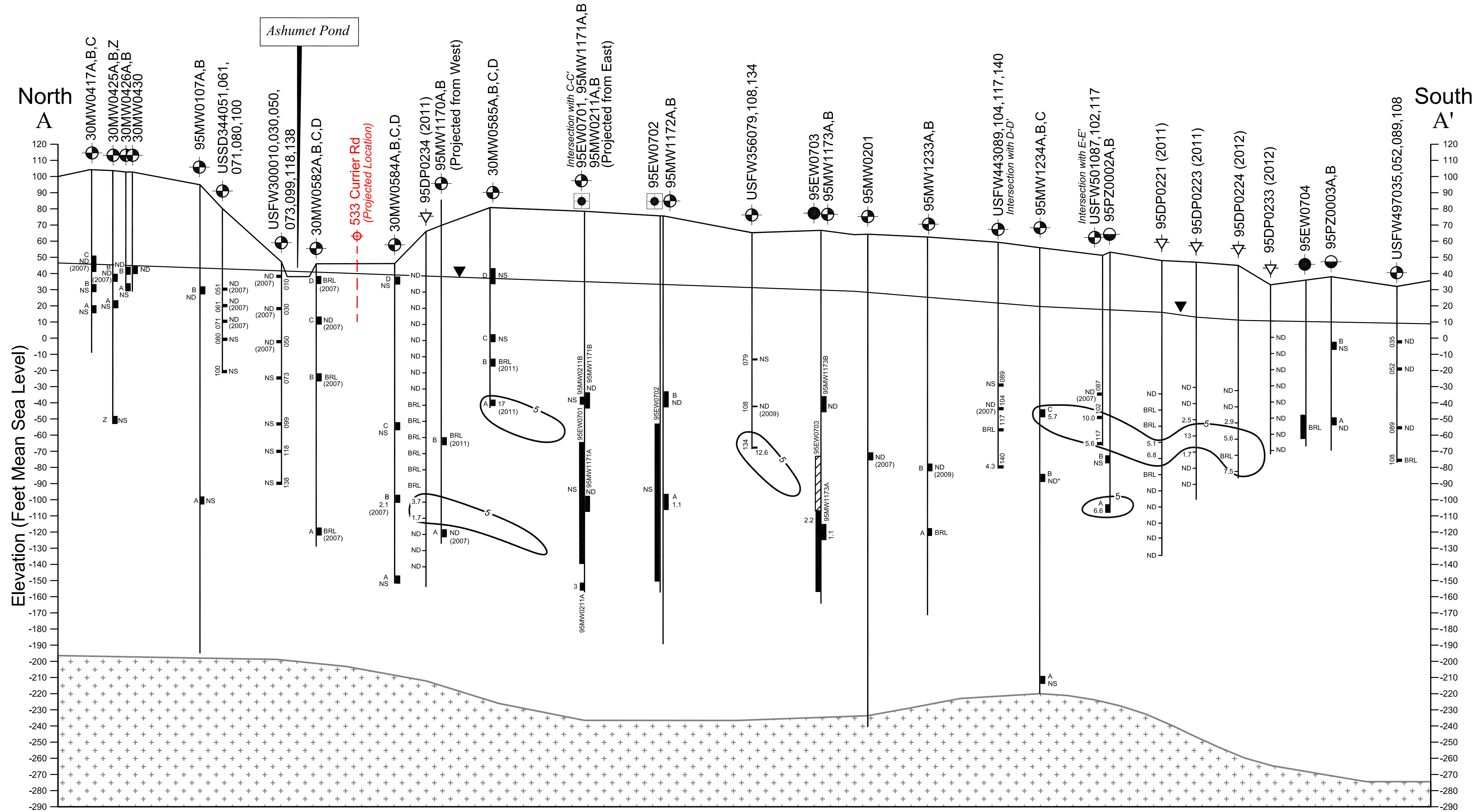
FIGURE 4

ASHUMET VALLEY PCE CROSS-SECTION A-A'

AFCEE - Massachusetts Military Reservation

26 January 2012 Technical Update Meeting (Modified With Private Well Location)

CH2MHILL



Legend

Monitoring Well		Piezometer		Private Well (Unknown Depth)		Groundwater Vertical Profile Results (µg/L) (December 2011/January 2012)	
Extraction Well (On)		Water Table	—5—	2011 TCE Isoconcentration Contour (Dashed Where Inferred)		Packered Well Screen	
Extraction Well (Off)	NS	Not Sampled	15	PCE Results (µg/L)		Bedrock	
Direct Push Location	ND	Nondetect	A 119	Well Screen ID			
	BRL	Below Reporting Limit					

Source: AFCEE, January 2012, MMR-AFCEE Data Warehouse.

Note: Data Presented Includes Most Recent Monitoring Results Through December 2010 (Triennial Wells) or August 2011 (Annual Wells) (Unless Otherwise Noted)

* One-time Sampling of 95MW1234B Conducted in October 2011

V: 60
H: 1335
0 Feet

FIGURE 5

ASHUMET VALLEY TCE CROSS-SECTION A-A'

AFCEE - Massachusetts Military Reservation

26 January 2012 Technical Update Meeting (Modified With Private Well Location)

CH2MHILL.

Technical Update Meeting - 09 December 2009
Borehole Preliminary Groundwater Screening Results
Boring 03MW1059A (Downgradient of 03EW2112 - Currier Road)

Sample Interval	Date Sampled	Depth TOS (ft bgs)	Depth BOS (ft bgs)	Mid-Depth (ft bgs)	Mid-Depth (ft msl)	TCE (µg/L) MCL = 5 µg/L	PCE (µg/L) MCL = 5 µg/L
A	10/12/09	25	30	27.5	28.5	ND	ND
B	10/13/09	35	40	37.5	18.5	ND	ND
C	10/13/09	45	50	47.5	8.5	ND	ND
D	10/13/09	55	60	57.5	-1.5	ND	ND
E	10/14/09	65	70	67.5	-11.5	ND	ND
F	10/14/09	75	80	77.5	-21.5	ND	ND
G	10/14/09	85	90	87.5	-31.5	ND	ND
H	10/14/09	95	100	97.5	-41.5	ND	ND
I	10/14/09	105	110	107.5	-51.5	BRL	ND
J	10/15/09	115	120	117.5	-61.5	BRL	ND
K	10/15/09	125	130	127.5	-71.5	BRL	ND
L	10/15/09	135	140	137.5	-81.5	ND	ND
M	10/15/09	145	150	147.5	-91.5	BRL	BRL
N	10/16/09	155	160	157.5	-101.5	2.2	BRL
O	10/16/09	165	170	167.5	-111.5	2.6	BRL
P	10/16/09	175	180	177.5	-121.5	BRL	ND
Q	10/16/09	185	190	187.5	-131.5	ND	ND
R	10/19/09	195	200	197.5	-141.5	ND	ND
S	10/19/09	205	210	207.5	-151.5	BRL	ND
T	10/19/09	215	220	217.5	-161.5	ND	ND
U	10/19/09	225	230	227.5	-171.5	ND	ND
V	10/20/09	235	240	237.5	-181.5	ND	ND
W	10/20/09	245	250	247.5	-191.5	ND	ND
X	10/20/09	255	260	257.5	-201.5	NS	NS

Data Source: AFCEE, October 2009, Analytics

Key:
BOS = bottom of sample
BRL = below reporting limit
ft bgs = feet below ground surface
ft msl = feet mean sea level
MCL = Maximum Contaminant Level
ND = not detected
NS = not sampled
PCE = tetrachloroethene
TCE = trichloroethene
TOS = top of sample
µg/L = micrograms per liter

Notes:
Ground surface elevation is approximately 56 ft msl.
03EW2112 screened from 148 to 208 ft bgs (-89.6 to -149.6 ft msl).
Bottom of boring was at 261 ft bgs (-205 ft msl).
Monitoring wells were installed from 205-210 ft bgs (03MW1059A), 165-170 ft bgs (03MW1059B), and 115-120 ft bgs (03MW1059C).

Summary of Groundwater Monitoring Results for PCE and TCE
03MW1059A,B,C

Location	Matrix	Test	Analyte	Depth	Date	Result	DL	RL	Units
03MW1059A	WG	SW8260B	TETRACHLOROETHENE (PCE)	207.3	5/3/2010	ND	0.07	1	µg/L
03MW1059A	WG	SW8260B	TETRACHLOROETHENE (PCE)	207.3	2/16/2011	ND	0.19	1	µg/L
03MW1059A	WG	SW8260B	TETRACHLOROETHENE (PCE)	207.3	11/17/2011	ND	0.19	1	µg/L
03MW1059A	WG	SW8260B	TRICHLOROETHENE (TCE)	207.3	5/3/2010	ND	0.14	1	µg/L
03MW1059A	WG	SW8260B	TRICHLOROETHENE (TCE)	207.3	2/16/2011	ND	0.2	1	µg/L
03MW1059A	WG	SW8260B	TRICHLOROETHENE (TCE)	207.3	11/17/2011	ND	0.2	1	µg/L
03MW1059B	WG	SW8260B	TETRACHLOROETHENE (PCE)	167.35	5/3/2010	BRL	0.07	1	µg/L
03MW1059B	WG	SW8260B	TETRACHLOROETHENE (PCE)	167.35	2/16/2011	ND	0.19	1	µg/L
03MW1059B	WG	SW8260B	TETRACHLOROETHENE (PCE)	167.35	11/17/2011	ND	0.19	1	µg/L
03MW1059B	WG	SW8260B	TRICHLOROETHENE (TCE)	167.35	5/3/2010	1.7	0.14	1	µg/L
03MW1059B	WG	SW8260B	TRICHLOROETHENE (TCE)	167.35	2/16/2011	BRL	0.2	1	µg/L
03MW1059B	WG	SW8260B	TRICHLOROETHENE (TCE)	167.35	11/17/2011	ND	0.2	1	µg/L
03MW1059C	WG	SW8260B	TETRACHLOROETHENE (PCE)	117.4	5/3/2010	ND	0.07	1	µg/L
03MW1059C	WG	SW8260B	TETRACHLOROETHENE (PCE)	117.4	2/16/2011	ND	0.19	1	µg/L
03MW1059C	WG	SW8260B	TETRACHLOROETHENE (PCE)	117.4	11/17/2011	ND	0.19	1	µg/L
03MW1059C	WG	SW8260B	TRICHLOROETHENE (TCE)	117.4	5/3/2010	BRL	0.14	1	µg/L
03MW1059C	WG	SW8260B	TRICHLOROETHENE (TCE)	117.4	2/16/2011	ND	0.2	1	µg/L
03MW1059C	WG	SW8260B	TRICHLOROETHENE (TCE)	117.4	11/17/2011	ND	0.2	1	µg/L

Data Source: AFCEE-MMR Data Warehouse, May 2012

Key:

BRL = below laboratory reporting limit

DL = detection limit

ND = non detect

µg/L = micrograms per liter

RL = laboratory reporting limit

WG = groundwater sample

Summary of Groundwater Monitoring Results for PCE and TCE
30MW0583A,B,C,D,E

Location	Matrix	Test	Analyte	Depth	Date	Result	DL	RL	Units
30MW0583A	WG	CVOL	TETRACHLOROETHENE (PCE)	170.5	8/12/1997	ND	0.41	1	µg/L
30MW0583A	WG	CVOL	TETRACHLOROETHENE (PCE)	170.5	7/12/1999	ND	0.22	1	µg/L
30MW0583A	WG	CVOL	TETRACHLOROETHENE (PCE)	170.5	9/27/1999	ND	0.1	1	µg/L
30MW0583A	WG	CVOL	TETRACHLOROETHENE (PCE)	170.5	1/26/2000	ND	0.1	1	µg/L
30MW0583A	WG	CVOL	TETRACHLOROETHENE (PCE)	170.5	3/27/2000	ND	0.11	1	µg/L
30MW0583A	WG	CVOL	TETRACHLOROETHENE (PCE)	170.5	6/28/2000	ND	0.11	1	µg/L
30MW0583A	WG	CVOL	TETRACHLOROETHENE (PCE)	170.5	9/27/2000	ND	0.11	1	µg/L
30MW0583A	WG	CVOL	TETRACHLOROETHENE (PCE)	170.5	12/21/2000	ND	0.11	1	µg/L
30MW0583A	WG	CVOL	TETRACHLOROETHENE (PCE)	170.5	4/3/2001	ND	0.11	1	µg/L
30MW0583A	WG	CVOL	TETRACHLOROETHENE (PCE)	170.5	5/29/2001	ND	0.11	1	µg/L
30MW0583A	WG	SW8260	TETRACHLOROETHENE (PCE)	170.5	9/11/2001	ND	0.161	1	µg/L
30MW0583A	WG	SW8260	TETRACHLOROETHENE (PCE)	170.5	4/5/2002	ND	0.146	1	µg/L
30MW0583A	WG	SW8260	TETRACHLOROETHENE (PCE)	170.5	10/29/2002	ND	0.146	1	µg/L
30MW0583A	WG	SW8260B	TETRACHLOROETHENE (PCE)	170.5	4/14/2003	BRL	0.137	1	µg/L
30MW0583A	WG	SW8260B	TETRACHLOROETHENE (PCE)	170.5	10/24/2003	ND	0.421	1	µg/L
30MW0583A	WG	SW8260B	TETRACHLOROETHENE (PCE)	170.5	5/13/2004	ND	1	1	µg/L
30MW0583A	WG	SW8260B	TETRACHLOROETHENE (PCE)	170.5	11/10/2004	BRL	0.18	1	µg/L
30MW0583A	WG	CVOL	TRICHLOROETHENE (TCE)	170.5	8/12/1997	ND	0.62	1	µg/L
30MW0583A	WG	CVOL	TRICHLOROETHENE (TCE)	170.5	7/12/1999	2.65	0.35	1	µg/L
30MW0583A	WG	CVOL	TRICHLOROETHENE (TCE)	170.5	9/27/1999	1.7	0.12	1	µg/L
30MW0583A	WG	CVOL	TRICHLOROETHENE (TCE)	170.5	1/26/2000	2	0.12	1	µg/L
30MW0583A	WG	CVOL	TRICHLOROETHENE (TCE)	170.5	3/27/2000	1.8	0.09	1	µg/L
30MW0583A	WG	CVOL	TRICHLOROETHENE (TCE)	170.5	6/28/2000	1.9	0.09	1	µg/L
30MW0583A	WG	CVOL	TRICHLOROETHENE (TCE)	170.5	9/27/2000	2.2	0.09	1	µg/L
30MW0583A	WG	CVOL	TRICHLOROETHENE (TCE)	170.5	12/21/2000	2.1	0.09	1	µg/L
30MW0583A	WG	CVOL	TRICHLOROETHENE (TCE)	170.5	4/3/2001	2.4	0.09	1	µg/L
30MW0583A	WG	CVOL	TRICHLOROETHENE (TCE)	170.5	5/29/2001	2.3	0.09	1	µg/L
30MW0583A	WG	SW8260	TRICHLOROETHENE (TCE)	170.5	9/11/2001	2.3	0.2	1	µg/L
30MW0583A	WG	SW8260	TRICHLOROETHENE (TCE)	170.5	4/5/2002	2.51	0.138	1	µg/L
30MW0583A	WG	SW8260	TRICHLOROETHENE (TCE)	170.5	10/29/2002	2.1	0.138	1	µg/L
30MW0583A	WG	SW8260B	TRICHLOROETHENE (TCE)	170.5	4/14/2003	2.28	0.203	1	µg/L
30MW0583A	WG	SW8260B	TRICHLOROETHENE (TCE)	170.5	10/24/2003	3	0.241	1	µg/L
30MW0583A	WG	SW8260B	TRICHLOROETHENE (TCE)	170.5	5/13/2004	1.8	0.14	1	µg/L
30MW0583A	WG	SW8260B	TRICHLOROETHENE (TCE)	170.5	11/10/2004	2.5	0.11	1	µg/L
30MW0583B	WG	CVOL	TETRACHLOROETHENE (PCE)	135.5	8/12/1997	ND	0.41	5	µg/L
30MW0583B	WG	CVOL	TETRACHLOROETHENE (PCE)	135.5	7/12/1999	1.3	0.22	1	µg/L
30MW0583B	WG	CVOL	TETRACHLOROETHENE (PCE)	135.5	9/27/1999	ND	1	10	µg/L
30MW0583B	WG	CVOL	TETRACHLOROETHENE (PCE)	135.5	1/26/2000	ND	0.2	2	µg/L
30MW0583B	WG	CVOL	TETRACHLOROETHENE (PCE)	135.5	3/27/2000	ND	0.11	1	µg/L
30MW0583B	WG	CVOL	TETRACHLOROETHENE (PCE)	135.5	6/28/2000	ND	0.22	2	µg/L
30MW0583B	WG	CVOL	TETRACHLOROETHENE (PCE)	135.5	9/27/2000	ND	0.44	4	µg/L
30MW0583B	WG	CVOL	TETRACHLOROETHENE (PCE)	135.5	12/21/2000	ND	0.55	5	µg/L
30MW0583B	WG	CVOL	TETRACHLOROETHENE (PCE)	135.5	4/3/2001	BRL	0.44	4	µg/L
30MW0583B	WG	CVOL	TETRACHLOROETHENE (PCE)	135.5	5/29/2001	BRL	0.44	4	µg/L
30MW0583B	WG	SW8260	TETRACHLOROETHENE (PCE)	135.5	9/12/2001	BRL	0.161	1	µg/L
30MW0583B	WG	SW8260	TETRACHLOROETHENE (PCE)	135.5	4/5/2002	1.51	0.146	1	µg/L
30MW0583B	WG	SW8260	TETRACHLOROETHENE (PCE)	135.5	10/29/2002	1.6	0.146	1	µg/L
30MW0583B	WG	SW8260B	TETRACHLOROETHENE (PCE)	135.5	4/14/2003	1.48	0.137	1	µg/L
30MW0583B	WG	SW8260B	TETRACHLOROETHENE (PCE)	135.5	10/24/2003	BRL	0.421	1	µg/L
30MW0583B	WG	SW8260B	TETRACHLOROETHENE (PCE)	135.5	5/13/2004	1.3	0.16	1	µg/L
30MW0583B	WG	SW8260B	TETRACHLOROETHENE (PCE)	135.5	11/10/2004	1.1	0.18	1	µg/L
30MW0583B	WG	CVOL	TRICHLOROETHENE (TCE)	135.5	8/12/1997	83	0.62	5	µg/L
30MW0583B	WG	CVOL	TRICHLOROETHENE (TCE)	135.5	7/12/1999	18.4	0.35	1	µg/L
30MW0583B	WG	CVOL	TRICHLOROETHENE (TCE)	135.5	9/27/1999	BRL	1.2	10	µg/L
30MW0583B	WG	CVOL	TRICHLOROETHENE (TCE)	135.5	1/26/2000	1.9	0.24	2	µg/L
30MW0583B	WG	CVOL	TRICHLOROETHENE (TCE)	135.5	3/27/2000	ND	0.09	1	µg/L
30MW0583B	WG	CVOL	TRICHLOROETHENE (TCE)	135.5	6/28/2000	ND	0.18	2	µg/L
30MW0583B	WG	CVOL	TRICHLOROETHENE (TCE)	135.5	9/27/2000	3.9	0.36	4	µg/L
30MW0583B	WG	CVOL	TRICHLOROETHENE (TCE)	135.5	12/21/2000	10	0.45	5	µg/L
30MW0583B	WG	CVOL	TRICHLOROETHENE (TCE)	135.5	4/3/2001	BRL	0.36	4	µg/L
30MW0583B	WG	CVOL	TRICHLOROETHENE (TCE)	135.5	5/29/2001	BRL	0.36	4	µg/L

Summary of Groundwater Monitoring Results for PCE and TCE
30MW0583A,B,C,D,E

Location	Matrix	Test	Analyte	Depth	Date	Result	DL	RL	Units
30MW0583B	WG	SW8260	TRICHLOROETHENE (TCE)	135.5	9/12/2001	2.73	0.2	1	µg/L
30MW0583B	WG	SW8260	TRICHLOROETHENE (TCE)	135.5	4/5/2002	BRL	0.138	1	µg/L
30MW0583B	WG	SW8260	TRICHLOROETHENE (TCE)	135.5	10/29/2002	BRL	0.138	1	µg/L
30MW0583B	WG	SW8260B	TRICHLOROETHENE (TCE)	135.5	4/14/2003	BRL	0.203	1	µg/L
30MW0583B	WG	SW8260B	TRICHLOROETHENE (TCE)	135.5	10/24/2003	1.7	0.241	1	µg/L
30MW0583B	WG	SW8260B	TRICHLOROETHENE (TCE)	135.5	5/13/2004	BRL	0.14	1	µg/L
30MW0583B	WG	SW8260B	TRICHLOROETHENE (TCE)	135.5	11/10/2004	BRL	0.11	1	µg/L
30MW0583C	WG	CVOL	TETRACHLOROETHENE (PCE)	86.5	8/12/1997	6.6	0.41	2	µg/L
30MW0583C	WG	CVOL	TETRACHLOROETHENE (PCE)	86.5	7/12/1999	ND	0.22	1	µg/L
30MW0583C	WG	CVOL	TETRACHLOROETHENE (PCE)	86.5	9/27/1999	ND	0.1	1	µg/L
30MW0583C	WG	CVOL	TETRACHLOROETHENE (PCE)	86.5	1/26/2000	ND	0.1	1	µg/L
30MW0583C	WG	CVOL	TETRACHLOROETHENE (PCE)	86.5	3/27/2000	ND	0.11	1	µg/L
30MW0583C	WG	CVOL	TETRACHLOROETHENE (PCE)	86.5	6/28/2000	ND	0.11	1	µg/L
30MW0583C	WG	CVOL	TETRACHLOROETHENE (PCE)	86.5	9/27/2000	ND	0.11	1	µg/L
30MW0583C	WG	CVOL	TETRACHLOROETHENE (PCE)	86.5	12/21/2000	ND	0.11	1	µg/L
30MW0583C	WG	CVOL	TETRACHLOROETHENE (PCE)	86.5	4/3/2001	BRL	0.11	1	µg/L
30MW0583C	WG	CVOL	TETRACHLOROETHENE (PCE)	86.5	5/29/2001	BRL	0.22	2	µg/L
30MW0583C	WG	CVOL	TETRACHLOROETHENE (PCE)	86.5	10/1/2001	BRL	0.26	2	µg/L
30MW0583C	WG	SW8260	TETRACHLOROETHENE (PCE)	86.5	4/5/2002	BRL	0.146	1	µg/L
30MW0583C	WG	SW8260	TETRACHLOROETHENE (PCE)	86.5	10/29/2002	1.05	0.146	1	µg/L
30MW0583C	WG	SW8260B	TETRACHLOROETHENE (PCE)	86.5	4/14/2003	2.53	0.137	1	µg/L
30MW0583C	WG	SW8260B	TETRACHLOROETHENE (PCE)	86.5	10/24/2003	BRL	0.421	1	µg/L
30MW0583C	WG	SW8260B	TETRACHLOROETHENE (PCE)	86.5	5/13/2004	1.3	0.16	1	µg/L
30MW0583C	WG	SW8260B	TETRACHLOROETHENE (PCE)	86.5	11/10/2004	BRL	0.18	1	µg/L
30MW0583C	WG	SW8260B	TETRACHLOROETHENE (PCE)	86.5	11/10/2004	BRL	0.18	1	µg/L
30MW0583C	WG	CVOL	TRICHLOROETHENE (TCE)	86.5	8/12/1997	11	0.62	2	µg/L
30MW0583C	WG	CVOL	TRICHLOROETHENE (TCE)	86.5	7/12/1999	ND	0.35	1	µg/L
30MW0583C	WG	CVOL	TRICHLOROETHENE (TCE)	86.5	9/27/1999	ND	0.12	1	µg/L
30MW0583C	WG	CVOL	TRICHLOROETHENE (TCE)	86.5	1/26/2000	ND	0.12	1	µg/L
30MW0583C	WG	CVOL	TRICHLOROETHENE (TCE)	86.5	3/27/2000	ND	0.09	1	µg/L
30MW0583C	WG	CVOL	TRICHLOROETHENE (TCE)	86.5	6/28/2000	ND	0.09	1	µg/L
30MW0583C	WG	CVOL	TRICHLOROETHENE (TCE)	86.5	9/27/2000	ND	0.09	1	µg/L
30MW0583C	WG	CVOL	TRICHLOROETHENE (TCE)	86.5	12/21/2000	ND	0.09	1	µg/L
30MW0583C	WG	CVOL	TRICHLOROETHENE (TCE)	86.5	4/3/2001	BRL	0.09	1	µg/L
30MW0583C	WG	CVOL	TRICHLOROETHENE (TCE)	86.5	5/29/2001	BRL	0.18	2	µg/L
30MW0583C	WG	CVOL	TRICHLOROETHENE (TCE)	86.5	10/1/2001	ND	0.3	2	µg/L
30MW0583C	WG	SW8260	TRICHLOROETHENE (TCE)	86.5	4/5/2002	BRL	0.138	1	µg/L
30MW0583C	WG	SW8260	TRICHLOROETHENE (TCE)	86.5	10/29/2002	BRL	0.138	1	µg/L
30MW0583C	WG	SW8260B	TRICHLOROETHENE (TCE)	86.5	4/14/2003	BRL	0.203	1	µg/L
30MW0583C	WG	SW8260B	TRICHLOROETHENE (TCE)	86.5	10/24/2003	BRL	0.24	1	µg/L
30MW0583C	WG	SW8260B	TRICHLOROETHENE (TCE)	86.5	5/13/2004	BRL	0.14	1	µg/L
30MW0583C	WG	SW8260B	TRICHLOROETHENE (TCE)	86.5	11/10/2004	ND	0.11	1	µg/L
30MW0583C	WG	SW8260B	TRICHLOROETHENE (TCE)	86.5	11/10/2004	ND	0.11	1	µg/L
30MW0583D	WG	CVOL	TETRACHLOROETHENE (PCE)	55.5	8/13/1997	ND	0.41	1	µg/L
30MW0583D	WG	CVOL	TETRACHLOROETHENE (PCE)	55.5	7/12/1999	ND	0.22	1	µg/L
30MW0583D	WG	CVOL	TRICHLOROETHENE (TCE)	55.5	8/13/1997	ND	0.62	1	µg/L
30MW0583D	WG	CVOL	TRICHLOROETHENE (TCE)	55.5	7/12/1999	ND	0.35	1	µg/L
30MW0583E	WG	CVOL	TETRACHLOROETHENE (PCE)	10.5	8/13/1997	ND	0.41	1	µg/L
30MW0583E	WG	CVOL	TETRACHLOROETHENE (PCE)	10.5	7/12/1999	ND	0.22	1	µg/L
30MW0583E	WG	CVOL	TRICHLOROETHENE (TCE)	10.5	8/13/1997	ND	0.62	1	µg/L
30MW0583E	WG	CVOL	TRICHLOROETHENE (TCE)	10.5	7/12/1999	ND	0.35	1	µg/L

Data Source: AFCEE-MMR Data Warehouse, May 2012

Key:

BRL = below laboratory reporting limit

DL = detection limit

ND = non detect

µg/L = micrograms per liter

RL = laboratory reporting limit

WG = groundwater sample

analytics environmental laboratory LLC

195 Commerce Way
Portsmouth, New Hampshire 03801
603-436-5111 Fax 603-430-2151
800-929-9906

Mr. Doug Scott
CH2M Hill
1748 West Truck Road/Otis ANG Base
Buzzards Bay MA 02542

June 6, 2013

SAMPLE DATA

Lab Sample ID: 75664-1
Matrix: Aqueous
Percent Solid: N/A
Dilution Factor: 1
Collection Date: 05/30/13
Lab Receipt Date: 05/31/13
Analysis Date: 06/05/13

CLIENT SAMPLE ID

Project Name: MMR 2013/05 LUC CS-10, CS-21, AV
Project Number: 437075.05.07.18
Field Sample ID: CHPE0533CU-O0513

ANALYTICAL RESULTS VOLATILE ORGANICS

COMPOUND	Detection Limit µg/L	Quantitation Limit µg/L	Result µg/L	COMPOUND	Detection Limit µg/L	Quantitation Limit µg/L	Result µg/L
1,1,1-Trichloroethane	0.18	1.0	U	Toluene	0.20	1.0	U
1,1-Dichloroethane	0.20	1.0	U	trans-1,2-Dichloroethene	0.20	1.0	U
1,2,4-Trichlorobenzene	0.21	1.0	U	trans-1,3-Dichloropropene	0.10	1.0	U
1,2-Dibromo-3-chloropropane	0.50	1.0	U	Trichloroethene	0.20	1.0	U
1,2-Dichlorobenzene	0.16	1.0	U	1,1,2,2-Tetrachloroethane	0.13	1.0	U
1,3-Dichlorobenzene	0.20	1.0	U	1,1,2-Trichloroethane	0.11	1.0	U
1,4-Dichlorobenzene	0.19	1.0	U	1,1-Dichloroethene	0.13	1.0	U
Benzene	0.20	1.0	U	1,2-Dibromoethane	0.15	1.0	U
Bromochloromethane	0.20	1.0	U	1,2-Dichloroethane	0.50	1.0	U
Chlorobenzene	0.17	1.0	U	1,2-Dichloropropane	0.50	1.0	U
Chloroform	0.20	1.0	U	Bromodichloromethane	0.15	1.0	U
cis-1,2-Dichloroethene	0.20	1.0	U	Bromoform	0.12	1.0	U
cis-1,3-Dichloropropene	0.10	1.0	U	Bromomethane	0.50	1.0	U
Ethylbenzene	0.20	1.0	U	Carbon Tetrachloride	0.20	1.0	U
Methylene Chloride	1.0	2.0	U	Chloroethane	0.50	1.0	U
o-Xylene	0.20	1.0	U	Chloromethane	0.20	1.0	U
m,p-Xylene	0.40	1.0	U	Dibromochloromethane	0.15	1.0	U
Styrene	0.20	1.0	U	Methyl-tert-butyl ether (MTBE)	0.20	1.0	U
Tetrachloroethene	0.19	1.0	U	Vinyl chloride	0.20	1.0	U

Surrogate Standard Recovery

Bromofluorobenzene 100% d4-1,2-Dichloroethane 102% d8-Toluene 101%

U=Undetected J=Estimated E=Exceeds Calibration Range B=Detected in Blank

METHODOLOGY: Sample analysis was conducted according to: Test Methods for Evaluating Solid Waste, SW-846 Method 8260B.

COMMENTS:

set2ColumnMDLandDL:Res(0):Rec(0) - CH2MMR(BI)-AQ-Short(noTMBs)_7_27_10

Authorized signature

Summary of Groundwater Monitoring Results for Manganese
RS0533CURR

Location	Matrix	Test	Analyte	Date	Result	DL	RL	Units
RS0533CURR	WG	SW6010B	MANGANESE	5/30/2013	ND	2.8	15	µg/L

Data Source: AFCEC-MMR Data Warehouse, July 2013

Key:

DL = detection limit

ND = non detect

RL = reporting limit

WG = groundwater

µg/L = micrograms per liter

WELL DETERMINATION

ADDRESS: 74 Round Pond Drive, Falmouth MA

APEMS ID: 43579

WELL STATUS: ACTIVE

WELL USE: Irrigation/outdoor use

SUMMARY: According to the property owner response, which is provided in the parcel summary report (attached), this residence is connected to the Falmouth municipal water supply. This residence receives a water bill from the Town of Falmouth. However, there is one private well located on this property that was restarted in 2013 and is used for outdoor purposes. The depth of this private well is unknown.

DATA REVIEW:

☑ SPEIM monitoring data are available in the vicinity of this well [see attached map].

- 69DP0124 [vertical profile data]
- 69DP0135 [vertical profile data]
- 69DP0146 [vertical profile data]
- 69MW0032B [vertical profile and monitoring data], [Figure 9 attached]
- 69MW0028A/69DP0141 (Vertical profile and monitoring data]
- Water table is approximately 23 ft bgs (i.e., 19 ft msl).

☑ Groundwater vertical profiling was completed at several locations in the vicinity of 74 Round Pond Drive (69DP0124, 69DP0135, 69DP0146, 69MW0032B, and 69MW0028A). 74 Round Pond Drive is located approximately 180 feet to the west and outside of the FS-28 plume. The results of groundwater vertical profiling (table attached) indicate that the top of the FS-28 plume near Round Pond Drive is at approximately -70 ft msl (93 feet below the water table). Groundwater monitoring wells are in place to monitor the location of the plume.

☑ Sampling results are available for this private well. A groundwater sample was collected from this private well in July 2013. No EDB was detected (laboratory report attached). This well was also sampled ten times between 1997 and 2001. No EDB was detected (table attached).

DETERMINATION: This property is located approximately 180 feet west of the FS-28 leading edge portion of the plume. The depth of this private well is not known, however no EDB has been detected in groundwater samples collected from this private well. Due to the relative distance of this well from the FS-28 plume intermittent use of this well for outdoor use is not expected to draw in groundwater with EDB concentrations greater than the MMCL.

PATH FORWARD: No further evaluation or sampling is required**.**

SAMPLING NEEDED: ☐**Yes** ☒**No**

RE-EVALUATE IN NEXT 5-YEAR REVIEW: ☒**Yes** ☐**No**

AFCEC MMR Land Use Controls
Parcel Summary

Report Produced: 9/20/2013

Name: SAVAGE DAVID L

Plume: FS28

Telephone No.

Mailing Address

AFCEE Plume: FS28

Mailing PO:

Mailing Street: 74 ROUND POND DR

Mailing City: EAST FALMOUTH

Mailing State: MA

Mailing ZIP: 02536-4737

Parcel Address

APEMS ID: 43579

Parcel Street: 74 ROUND POND DR

Parcel City: Falmouth

Parcel State:

Parcel ZIP:

Town Numbers

Map: 21 *Section:* 04 *Parcel:* 003 *Lot:* 95R

Residential Well Notes: The property owner indicated in 2013 that this well has been restarted for intermittent outdoor use.

Irrigation Well Notes: Well has been reactivated per owner's email response. Owner states it is used only for outdoor irrigation purposes. This is a change from prior survey response. Private well sampled by AFCEC for EDB analysis on 08 July 2013.

Town Water Notes: Existing Town of Falmouth water account (May 2007)

Other Notes:

☐ Checked if the parcel respond to the state's 5-Star survey.

☐ Checked if AFCEE has been in contact with the parcel and no contact is needed.

Initial Mailing Sent?	☑	*Date Sent:*	4/27/2009	*Date Returned:*	5/6/2009
Second Mailing Sent?	☐	*Date Sent:*		*Date Returned:*	
Third Mailing Sent?	☐	*Date Sent:*		*Date Returned:*	
Contacted by Phone?	☐	*Date Contacted:*		*Contact Note:*	
Contacted by Email?	☐	*Email Date:*		*Date Returned::*	
Contacted In-Person?	☐	*Date Contacted:*			
Field Visit Performed?	☐	*Field Visit Date:*		*Field Visit Note:*	

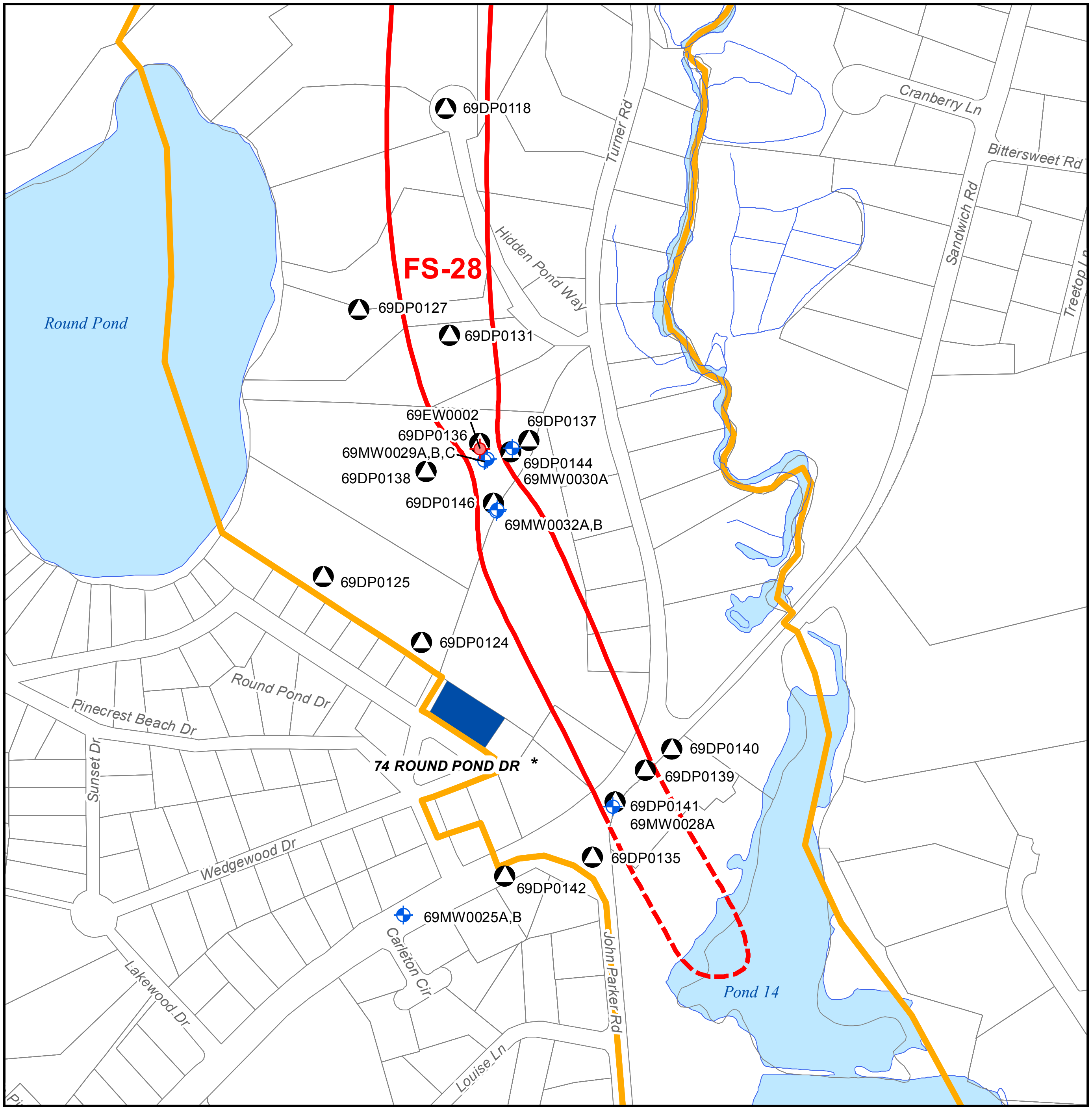
Other Contact Notes:

Wells associated with this parcel:

LocID

Functional?	☑	***Depth***	0	***Decomissioned?***	☐	***Well Deemed Safe?***	☐
Non-Functional?	☐	***Pump Rate***	0	***Decomission Offer Made?***	☐	***Date:***	
Other Status?				***Decomission Offer Received?***	☐		

Path: Y:\Figures\General\LUC\2013\5thYrReview\LUC_13LUC_43579_RoundPond74.mxd Date: 7/10/2013 Time: 9:13:25 AM User: 1268507872E



Legend

- Plume Boundary
- LUC Area
- Parcel of Interest *
- Other Parcel
- Monitoring Well
- Extraction Well
- Borehole

* Note: Private Well Sampled in 2013

N

0 180 360 Feet

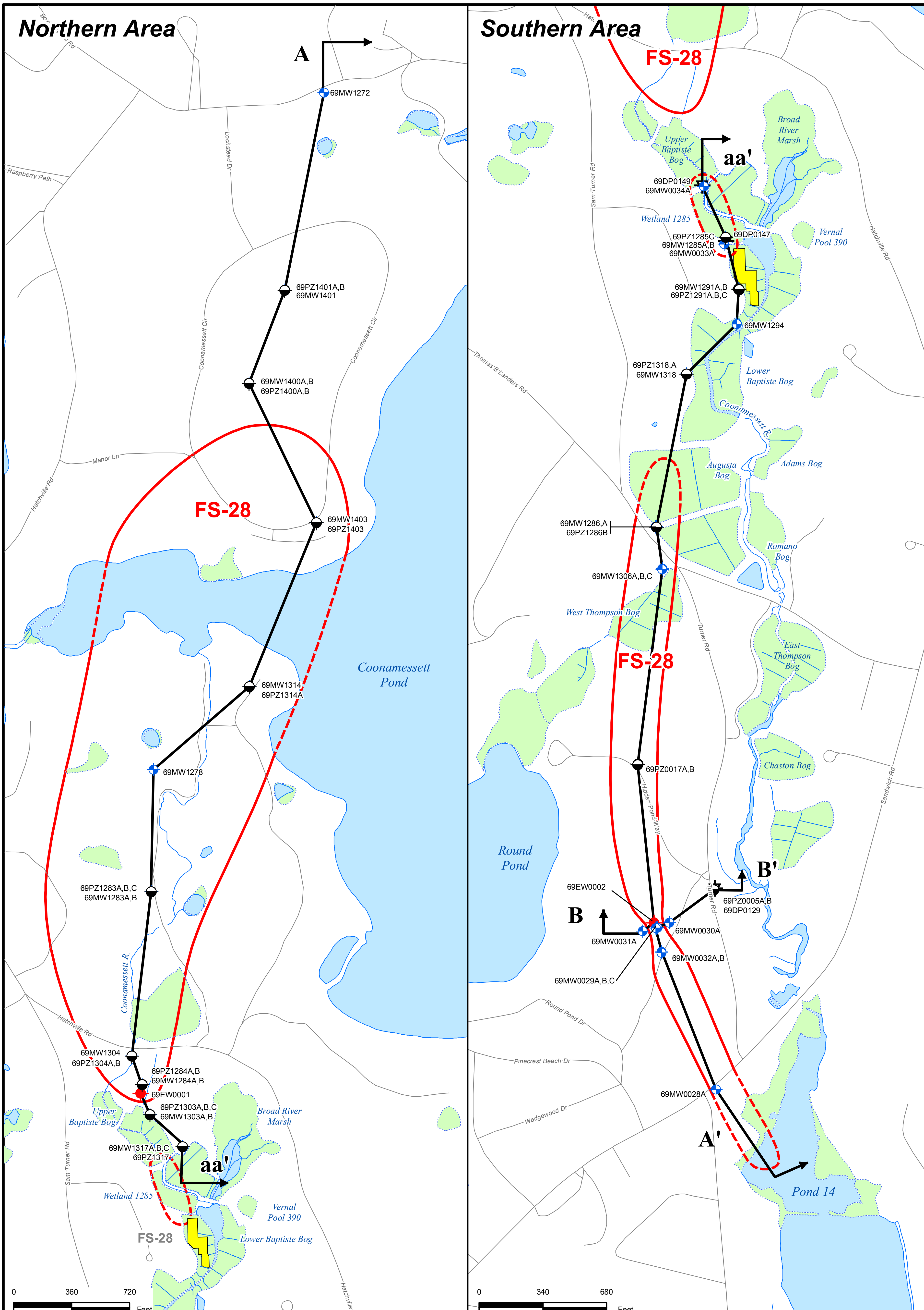
Data Source: AFCEC, MMR-AFCEC Data Warehouse

LOCATION: 74 ROUND POND DR

AFCEC - Massachusetts Military Reservation

FS-28 Land Use Control

CH2MHILL®



Last Opened 9/13/2011 3:21:03 PM by 12 \\52MPLS-FS-443\LEGACY$\Figures\General\LUC\2011\WellDeterminations\GIS\Arcmap\LUC_11determ_FigA-01.mxd

Legend

- Direct Push Location
- Extraction Well
- Monitoring Well
- Piezometer
- Shallow Wellpoints
- Transect
- FS-28 2009 EDB Plume Boundary (Dashed Where Inferred)
- Bog/Wetland

Data Source: AFCEE, March 2010, MMR-AFCEE Data Warehouse

N

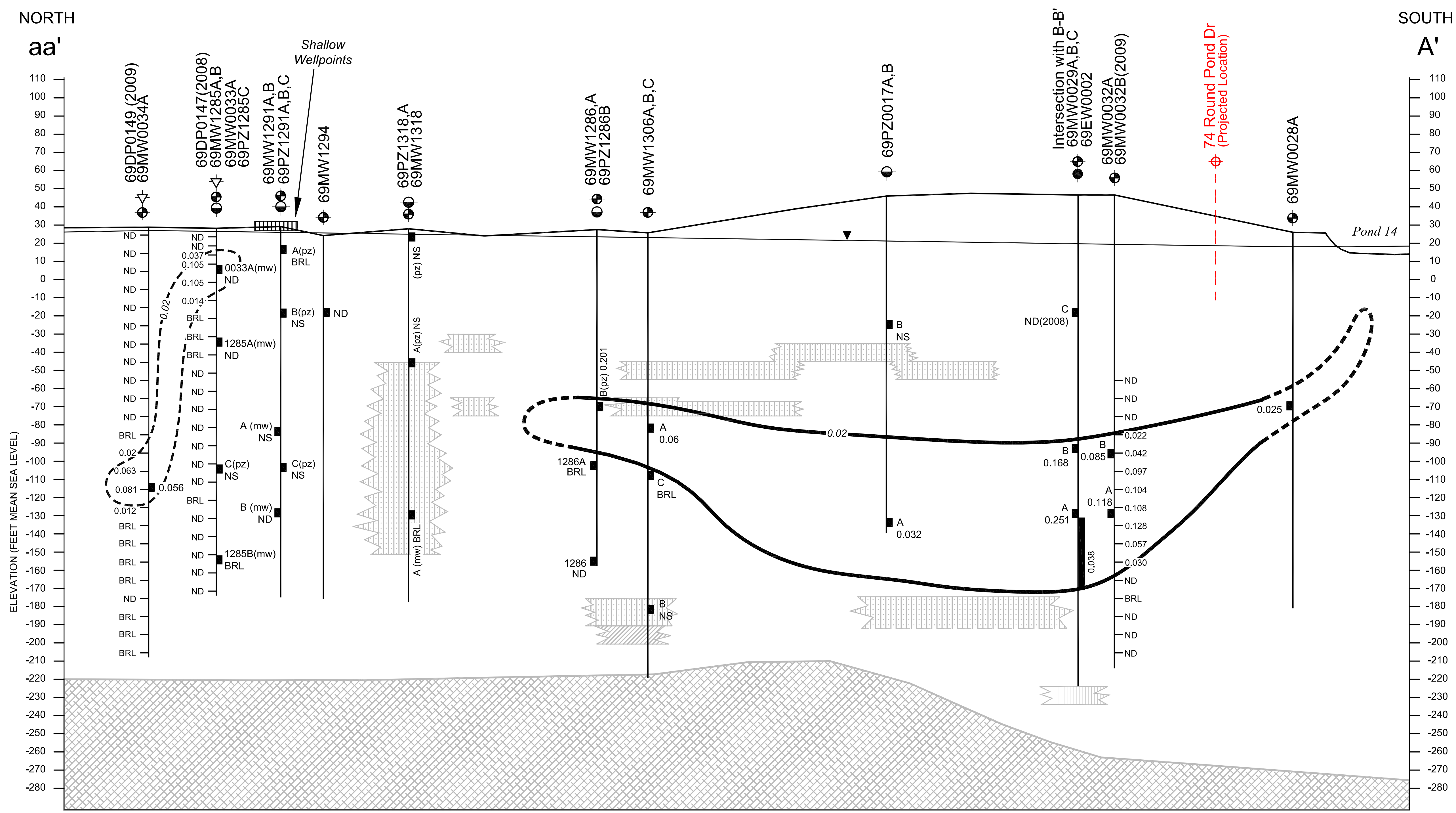
FIGURE A-1

FS-28 PLUME AND LOCATION OF CROSS-SECTION LINES

AFCEE - Massachusetts Military Reservation

Fuel Spill-28 and Southwest Plumes 2011 Private Well Verification and Well Determination Project Note

CH2MHILL.



Legend

Monitoring Well	A — Well Screen ID	—0.02— 2009 Plume Boundary (Dashed Where Inferred) (MMCL = 0.02 µg/L)	Silt
Piezometer	NS — Not Sampled	0.162 — Monitoring Well EDB Results (µg/L) (Latest Available Data)	Clay
Extraction Well	ND — Nondetect	1.14 — Direct Push EDB Screening Data (µg/L)	Silty Sand
Direct Push Location	NR — Not Representative	Private Well (Unknown Depth)	Bedrock
Water Table	BRL — Below Reporting Limit		

Data Source: AFCEE, September 2009, MMR AFCEE Data Warehouse

NOTE: Lithology at direct push locations is inferred from purge water observations. Date of borehole screening data is noted on figure.

0 V: 60 H: 480 Feet

FIGURE 9

FS-28 CROSS-SECTION aa'-A'

AFCEE-Massachusetts Military Reservation

Conceptual Site Model (Modified With Private Well Location)

CH2MHILL

Summary of Groundwater Monitoring Results
FS-28 Area

Location	Date	Matrix	Sample Elevation (ft msl)	Analytical Method	EDB Result	DL	RL	Units
69DP0124	9/1/2005	WA	10.5	E504.1	ND	0.002	0.01	µg/L
69DP0124	9/1/2005	WA	0.5	E504.1	ND	0.002	0.01	µg/L
69DP0124	9/1/2005	WA	-9.5	E504.1	ND	0.002	0.01	µg/L
69DP0124	9/6/2005	WA	-19.5	E504.1	ND	0.002	0.01	µg/L
69DP0124	9/6/2005	WA	-29.5	E504.1	ND	0.002	0.01	µg/L
69DP0124	9/6/2005	WA	-39.5	E504.1	ND	0.002	0.01	µg/L
69DP0124	9/6/2005	WA	-49.5	E504.1	ND	0.002	0.01	µg/L
69DP0124	9/6/2005	WA	-59.5	E504.1	ND	0.002	0.01	µg/L
69DP0124	9/6/2005	WA	-69.5	E504.1	ND	0.002	0.01	µg/L
69DP0124	9/6/2005	WA	-79.5	E504.1	ND	0.002	0.01	µg/L
69DP0124	9/7/2005	WA	-89.5	E504.1	ND	0.002	0.01	µg/L
69DP0124	9/7/2005	WA	-99.5	E504.1	ND	0.002	0.01	µg/L
69DP0124	9/7/2005	WA	-109.5	E504.1	ND	0.002	0.01	µg/L
69DP0124	9/8/2005	WA	-119.5	E504.1	ND	0.002	0.01	µg/L
69DP0124	9/8/2005	WA	-129.5	E504.1	ND	0.002	0.01	µg/L
69DP0135	5/24/2006	WA	12.5	E504.1	ND	0.002	0.01	µg/L
69DP0135	5/24/2006	WA	2.5	E504.1	ND	0.002	0.01	µg/L
69DP0135	5/24/2006	WA	-7.5	E504.1	ND	0.002	0.01	µg/L
69DP0135	5/24/2006	WA	-17.5	E504.1	ND	0.002	0.01	µg/L
69DP0135	5/24/2006	WA	-27.5	E504.1	ND	0.002	0.01	µg/L
69DP0135	5/24/2006	WA	-37.5	E504.1	ND	0.002	0.01	µg/L
69DP0135	5/30/2006	WA	-47.5	E504.1	ND	0.002	0.01	µg/L
69DP0135	5/30/2006	WA	-57.5	E504.1	ND	0.002	0.01	µg/L
69DP0135	5/30/2006	WA	-67.5	E504.1	ND	0.002	0.01	µg/L
69DP0135	5/30/2006	WA	-77.5	E504.1	ND	0.002	0.01	µg/L
69DP0135	5/30/2006	WA	-87.5	E504.1	ND	0.002	0.01	µg/L
69DP0135	5/30/2006	WA	-97.5	E504.1	ND	0.002	0.01	µg/L
69DP0135	5/30/2006	WA	-107.5	E504.1	ND	0.002	0.01	µg/L
69DP0135	5/30/2006	WA	-117.5	E504.1	ND	0.002	0.01	µg/L
69DP0135	5/31/2006	WA	-127.5	E504.1	ND	0.002	0.01	µg/L
69DP0135	5/31/2006	WA	-137.5	E504.1	ND	0.002	0.01	µg/L
69DP0135	5/31/2006	WA	-147.5	E504.1	ND	0.002	0.01	µg/L
69DP0135	5/31/2006	WA	-157.5	E504.1	ND	0.002	0.01	µg/L
69DP0135	5/31/2006	WA	-167.5	E504.1	ND	0.002	0.01	µg/L
69DP0135	6/1/2006	WA	-177.5	E504.1	ND	0.002	0.01	µg/L
69DP0135	6/1/2006	WA	-187.5	E504.1	ND	0.002	0.01	µg/L
69DP0141	3/15/2007	WA	8.5	E504.1	ND	0.003	0.01	µg/L
69DP0141	3/15/2007	WA	-1.5	E504.1	ND	0.003	0.01	µg/L
69DP0141	3/15/2007	WA	-11.5	E504.1	ND	0.003	0.01	µg/L
69DP0141	3/19/2007	WA	-21.5	E504.1	ND	0.003	0.01	µg/L
69DP0141	3/19/2007	WA	-31.5	E504.1	ND	0.003	0.01	µg/L
69DP0141	3/19/2007	WA	-41.5	E504.1	ND	0.003	0.01	µg/L
69DP0141	3/19/2007	WA	-51.5	E504.1	BRL	0.003	0.01	µg/L
69DP0141	3/19/2007	WA	-61.5	E504.1	ND	0.003	0.01	µg/L
69DP0141	3/19/2007	WA	-71.5	E504.1	0.093	0.003	0.01	µg/L
69DP0141	3/19/2007	WA	-81.5	E504.1	0.035	0.003	0.01	µg/L
69DP0141	3/19/2007	WA	-91.5	E504.1	0.011	0.003	0.01	µg/L
69DP0141	3/21/2007	WA	-101.5	E504.1	ND	0.003	0.01	µg/L
69DP0141	3/21/2007	WA	-111.5	E504.1	ND	0.003	0.01	µg/L
69DP0141	3/21/2007	WA	-121.5	E504.1	ND	0.003	0.01	µg/L
69DP0141	3/22/2007	WA	-131.5	E504.1	ND	0.003	0.01	µg/L
69DP0141	3/22/2007	WA	-141.5	E504.1	ND	0.003	0.01	µg/L

Summary of Groundwater Monitoring Results
FS-28 Area

Location	Date	Matrix	Sample Elevation (ft msl)	Analytical Method	EDB Result	DL	RL	Units
69DP0141	3/22/2007	WA	-151.5	E504.1	ND	0.003	0.01	µg/L
69DP0141	3/22/2007	WA	-161.5	E504.1	ND	0.003	0.01	µg/L
69DP0141	3/23/2007	WA	-171.5	E504.1	ND	0.003	0.01	µg/L
69DP0146	9/6/2007	WA	13.5	E504.1	ND	0.002	0.01	µg/L
69DP0146	9/6/2007	WA	3.5	E504.1	ND	0.002	0.01	µg/L
69DP0146	9/6/2007	WA	-6.5	E504.1	ND	0.002	0.01	µg/L
69DP0146	9/6/2007	WA	-16.5	E504.1	ND	0.002	0.01	µg/L
69DP0146	9/6/2007	WA	-26.5	E504.1	ND	0.002	0.01	µg/L
69DP0146	9/6/2007	WA	-36.5	E504.1	ND	0.002	0.01	µg/L
69DP0146	9/6/2007	WA	-46.5	E504.1	ND	0.002	0.01	µg/L
69DP0146	9/7/2007	WA	-56.5	E504.1	ND	0.002	0.01	µg/L
69DP0146	9/7/2007	WA	-66.5	E504.1	ND	0.002	0.01	µg/L
69DP0146	9/7/2007	WA	-76.5	E504.1	ND	0.002	0.01	µg/L
69DP0146	9/7/2007	WA	-86.5	E504.1	BRL	0.002	0.01	µg/L
69DP0146	9/7/2007	WA	-96.5	E504.1	0.084	0.002	0.01	µg/L
69DP0146	9/7/2007	WA	-106.5	E504.1	0.124	0.002	0.01	µg/L
69DP0146	9/7/2007	WA	-116.5	E504.1	0.386	0.002	0.01	µg/L
69DP0146	9/7/2007	WA	-126.5	E504.1	0.334	0.002	0.01	µg/L
69DP0146	9/10/2007	WA	-136.5	E504.1	0.316	0.002	0.01	µg/L
69DP0146	9/10/2007	WA	-146.5	E504.1	0.332	0.002	0.01	µg/L
69DP0146	9/10/2007	WA	-156.5	E504.1	0.18	0.002	0.01	µg/L
69DP0146	9/10/2007	WA	-166.5	E504.1	0.144	0.002	0.01	µg/L
69DP0146	9/10/2007	WA	-176.5	E504.1	0.092	0.002	0.01	µg/L
69DP0146	9/10/2007	WA	-186.5	E504.1	0.012	0.002	0.01	µg/L
69DP0146	9/11/2007	WA	-196.5	E504.1	ND	0.002	0.01	µg/L
69DP0146	9/11/2007	WA	-206.5	E504.1	ND	0.002	0.01	µg/L
69MW0028A	10/30/2007	WG	-69.83	E504.1	0.03	0.002	0.01	µg/L
69MW0028A	8/26/2008	WG	-69.83	E504.1	0.015	0.002	0.01	µg/L
69MW0028A	4/8/2009	WG	-69.83	E504.1	0.025	0.002	0.01	µg/L
69MW0028A	2/2/2010	WG	-69.83	E504.1	0.103	0.003	0.01	µg/L
69MW0028A	2/18/2011	WG	-69.83	E504.1	0.011	0.005	0.01	µg/L
69MW0028A	2/15/2012	WG	-69.83	E504.1	ND	0.005	0.01	µg/L
69MW0028A	1/30/2013	WG	-69.83	E504.1	ND	0.005	0.01	µg/L
69MW0032A	10/30/2007	WG	-129.16	E504.1	0.404	0.004	0.02	µg/L
69MW0032A	8/26/2008	WG	-129.16	E504.1	0.046	0.002	0.01	µg/L
69MW0032A	4/7/2009	WG	-129.16	E504.1	0.118	0.002	0.01	µg/L
69MW0032A	8/18/2009	WG	-129.16	E504.1	0.056	0.003	0.01	µg/L
69MW0032A	1/13/2010	WG	-129.16	E504.1	0.059	0.003	0.01	µg/L
69MW0032A	5/27/2010	WG	-129.16	E504.1	ND	0.005	0.01	µg/L
69MW0032A	7/12/2010	WG	-129.16	E504.1	ND	0.005	0.01	µg/L
69MW0032A	2/18/2011	WG	-129.16	E504.1	ND	0.005	0.01	µg/L
69MW0032A	8/15/2011	WG	-129.16	E504.1	ND	0.005	0.01	µg/L
69MW0032A	2/15/2012	WG	-129.16	E504.1	ND	0.005	0.01	µg/L
69MW0032A	1/30/2013	WG	-129.16	E504.1	BRL	0.005	0.01	µg/L
69MW0032A	5/30/2013	WG	-129.16	E504.1	0.016	0.005	0.01	µg/L
69MW0032B	4/14/2009	WA	-56.59	E504.1	ND	0.002	0.01	µg/L
69MW0032B	4/14/2009	WA	-66.59	E504.1	ND	0.002	0.01	µg/L
69MW0032B	4/14/2009	WA	-76.59	E504.1	ND	0.002	0.01	µg/L
69MW0032B	4/14/2009	WA	-86.59	E504.1	0.022	0.002	0.01	µg/L
69MW0032B	4/14/2009	WA	-96.59	E504.1	0.042	0.002	0.01	µg/L
69MW0032B	4/14/2009	WA	-106.59	E504.1	0.097	0.002	0.01	µg/L
69MW0032B	4/15/2009	WA	-116.59	E504.1	0.104	0.002	0.01	µg/L

Summary of Groundwater Monitoring Results
FS-28 Area

Location	Date	Matrix	Sample Elevation (ft msl)	Analytical Method	EDB Result	DL	RL	Units
69MW0032B	4/15/2009	WA	-126.59	E504.1	0.108	0.002	0.01	µg/L
69MW0032B	4/15/2009	WA	-136.59	E504.1	0.128	0.002	0.01	µg/L
69MW0032B	4/16/2009	WA	-146.59	E504.1	0.057	0.002	0.01	µg/L
69MW0032B	4/16/2009	WA	-156.59	E504.1	0.03	0.002	0.01	µg/L
69MW0032B	4/17/2009	WA	-166.59	E504.1	ND	0.002	0.01	µg/L
69MW0032B	4/17/2009	WA	-176.59	E504.1	BRL	0.002	0.01	µg/L
69MW0032B	4/17/2009	WA	-186.59	E504.1	ND	0.002	0.01	µg/L
69MW0032B	4/20/2009	WA	-196.59	E504.1	ND	0.002	0.01	µg/L
69MW0032B	4/20/2009	WA	-206.59	E504.1	ND	0.002	0.01	µg/L
69MW0032B	6/8/2009	WG	-96.47	E504.1	0.085	0.003	0.01	µg/L
69MW0032B	8/18/2009	WG	-96.47	E504.1	0.123	0.003	0.01	µg/L
69MW0032B	1/13/2010	WG	-96.47	E504.1	0.033	0.003	0.01	µg/L
69MW0032B	5/6/2010	WG	-96.47	E504.1	ND	0.005	0.01	µg/L
69MW0032B	7/12/2010	WG	-96.47	E504.1	ND	0.005	0.01	µg/L
69MW0032B	2/18/2011	WG	-96.47	E504.1	ND	0.005	0.01	µg/L
69MW0032B	8/15/2011	WG	-96.47	E504.1	ND	0.005	0.01	µg/L
69MW0032B	2/15/2012	WG	-96.47	E504.1	ND	0.005	0.01	µg/L
69MW0032B	1/30/2013	WG	-96.47	E504.1	0.155	0.005	0.01	µg/L
69MW0032B	5/30/2013	WG	-96.47	E504.1	0.224	0.005	0.01	µg/L

Data Source: AFCEC-MMR Data Warehouse, July 2013

Key:

BRL = below reporting limit

DL = detection limit

ft msl = feet mean sea level

ND = non detect

µg/L = micrograms per liter

RL = reporting limit

WG = groundwater sample

WA = groundwater vertical profiling sample

Project Name:	07 LUC FS-28/CFIG	**Lab Number:**	L1312714
Project Number:	437075.05.07.18	**Report Date:**	07/10/13

SAMPLE RESULTS

Lab ID:	L1312714-01	Date Collected:	07/08/13 10:15
Client ID:	CHPL00074RO-O0713	Date Received:	07/09/13
Sample Location:	MMR 2013	Field Prep:	Not Specified
Matrix:	Water		
Analytical Method:	14,504.1	Extraction Date:	07/09/13 18:50
Analytical Date:	07/10/13 01:03		
Analyst:	SR		

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor
Microextractables by GC - Westborough Lab						
1,2-Dibromoethane	ND		ug/l	0.010	0.003	1

Surrogate	% Recovery	Qualifier	Acceptance Criteria	Column
1,1,1,2-Tetrachloroethane	109		80-120	A

ALPHA ANALYTICAL

Private Well Sampling Results
74 Round Pond Drive

Location	Date	Test	Analyte	Result	DL	RL	Units
RS0074ROPO	4/17/1997	E504	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	ND	0.0044	0.02	µg/L
RS0074ROPO	9/17/1997	E504	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	ND	0.006	0.01	µg/L
RS0074ROPO	6/22/1998	E504	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	ND	0.0047	0.01	µg/L
RS0074ROPO	9/22/1998	E504	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	ND	0.0047	0.01	µg/L
RS0074ROPO	5/7/1999	E504	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	ND	0.0027	0.01	µg/L
RS0074ROPO	10/6/1999	E504	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	ND	0.0027	0.01	µg/L
RS0074ROPO	5/18/2000	E504	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	ND	0.0051	0.01	µg/L
RS0074ROPO	8/29/2000	E504	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	ND	0.0051	0.01	µg/L
RS0074ROPO	6/4/2001	E504	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	ND	0.005	0.01	µg/L
RS0074ROPO	9/27/2001	E504	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	ND	0.0039	0.01	µg/L

Data Source: AFCEC-MMR Data Warehouse, July 2013

Key:

DL = detection limit

ND = non detect

RL = reporting limit

µg/L = micrograms per liter

APPENDIX E

Regulatory Comment Resolution Documentation and Concurrence Letters

DEPARTMENT OF THE AIR FORCE
AIR FORCE CIVIL ENGINEER CENTER
INSTALLATION RESTORATION PROGRAM
OTIS AIR NATIONAL GUARD BASE, MA 02542-1320

26 September 2013

HQ AFCEC/JBCC
322 East Inner Road
Otis ANG Base, MA 02542-5028

Mr. Robert Lim
United States Environmental Protection Agency
Region One
5 Post Office Square – Suite 100
Mail Code 0SRR7-3
Boston, MA 02109-3912

Mr. Leonard Pinaud
Massachusetts Department of Environmental Protection
Southeast Region
20 Riverside Drive
Lakeville, MA 02347

Dear Mr. Lim and Mr. Pinaud:

Attached please find the Air Force Civil Engineer Center's responses to comments for the document entitled *Draft 4th Five Year Review, 2007-2012, Massachusetts Military Reservation (MMR) Superfund Site, Otis Air National Guard Base, MA* dated July 2013.

We look forward to your comments/approval by **01 October 2013**.

If you have any further questions or comments, please contact me at (508) 968-4670, extension 4952.

Sincerely,

JONATHAN S. DAVIS
Remediation Program Manager

Attachment:
Responses to Comments

THE AIR FORCE CIVIL ENGINEER CENTER
RESPONSES TO EPA COMMENTS ON THE
DRAFT 4TH FIVE-YEAR REVIEW, 2007-2012 MASSACHUSETTS MILITARY RESERVATION (MMR) SUPERFUND SITE, OTIS AIR NATIONAL GUARD BASE, MA, DATED JULY 2013

GENERAL COMMENTS:

1. EPA disagrees with the decision to develop ESDs for groundwater plumes, especially FS-12 and LF-1, because current projections show restoration years to be greater than the original ROD estimate. EPA requests that AFCEC continue with its optimization process which in the past has presented alternatives with additions to the existing treatment systems with performance analytics and order of magnitude cost estimates, so that remedial management decisions can be jointly made. Therefore, as expressed in specific comments below, EPA requests the recommendation and follow-up action to be submission of an optimization analysis which includes alternatives to achieve the timeframes in the ROD.

   Response: AFCEC intends to continue with its established optimization process including working with EPA and MassDEP so remedial management decisions can be jointly made. AFCEC believes this process was effective on the recent CS-10 remedial system optimization evaluation where achieving the model-predicted system operation and aquifer restoration timeframes presented in the ROD were balanced with life-cycle cost analysis. Therefore, as noted in responses to EPA Specific Comments 14 and 17, optimization evaluations will be completed at FS-12 and LF-1 which will assess alternatives to achieve the system operation and aquifer restoration timeframes presented in the RODs prior to deciding whether an ESD might be required.

2. Request for Enforceable Schedule for PFSA and FTA-2/LF-2 – EPA notes that these two operable units have recommendations & follow-up actions which include preparation of Focused Feasibility Studies, Proposed Plan and Records of Decision. EPA therefore request submission of separate, draft enforceable milestones for PFSA and FTA-2/LF-2 operable units.

   Response: Concur. AFCEC will forward a proposed Enforceable Schedule for these activities in early FY14.

3. Emerging Contaminants – EPA requests that specific language be added to the recommendations section of the five year review to address 1,4 Dioxane & PFCs which are emerging contaminants. Where 1,4 Dioxane and/or PFCs are potential problems (i.e., associated with source area activities), the plume specific section text and Table 1-4 should specifically state that a sampling and analysis plan shall be submitted to assess the possible presence of 1,4 Dioxane and/or PFCs shall be developed and implemented.

   Response: It is considered that the following plumes/sites have the potential for the presence of 1,4-dioxane given that chlorinated volatile organic compounds are contaminants of concern: the CS-4, CS-10, CS-20, CS-21, CS-23, LF-1, and SD-5

groundwater plumes/sites. Therefore, the text that discusses the topic of emerging contaminants in the "Issues, Recommendations, and Follow-Up Actions" sub-sections for each of these plumes/sites in Section 5.0 will be revised to read:

"In addition, the topic of emerging contaminants should be monitored as it relates to groundwater at the MMR. Specifically for ([*insert applicable site*:] CS-4, CS-10, CS-20, CS-21, CS-23, LF-1, or SD-5) groundwater, a sampling and analysis plan shall be submitted to the regulatory agencies to assess the possible presence of 1,4-dioxane."

Given the source history at the Ashumet Valley plume, there is potential that both 1,4-dioxane and perfluorinated compounds (associated with FTA-1) are present. Therefore, the text that discusses the topic of emerging contaminants at Ashumet Valley (Section 5.1.7 "Issues, Recommendations, and Follow-Up Actions") will be revised to read:

"………., the topic of emerging contaminants should be monitored as it relates to groundwater at the MMR. Specifically for AV groundwater, sampling and analysis plans shall be submitted to the regulatory agencies to assess the possible presence of 1,4-dioxane and perfluorinated compounds."

These plume specific recommendations to assess the potential presence of 1,4-dioxane and perfluorinated compounds (Ashumet Valley only) will be added to Table 1-4.

AFCEC is not proposing to evaluate the presence of 1,4-dioxane and perfluorinated compounds at the fuel spill groundwater plumes/sites (FS-1, FS-12, FS-13, FS-28, FS-29) or at CS-19 based on their source histories.

4. Table 1-4 –

   a. EPA reviewed the "Recommendation/Follow-up Actions" for simplicity, and provided suggestions so that the follow-up actions are actionable & trackable. The text in the "Recommendation/Follow-up Action Summary" appears to provide sufficient explanation. See specific comments below for suggestions.

   Response: Comment noted; revisions will be made based on specific comments below.

b. "Recommended Implementation Date" – Suggest prioritizing & rescheduling dates so that not all of the implementation dates fall in November 2014 which appears to generate a bottleneck.

<u>Response</u>: The "Recommended Implementation Date" presented in Table 1-4 was a projected completion date based on the current contract; the intent was not to generate the perception of a bottleneck in November 2014. The "Recommended Implementation Date" presented in Table 1-4 (attached) has been revised to represent the anticipated start date for the related activity and the schedule will be staggered over the period October 2013 through November 2014 for the majority of the deliverables that are currently under contract.

5. This document should include a Five Year Review Summary Form (i.e., Executive Summary with summary table for issues and recommendations). Suggest streamlining Table 1-4 to include only issues & follow-up actions and placing in this front-of-the document section. Please provide a draft with the response to comment letter.

   <u>Response</u>: An Executive Summary, which includes the Five Year Review Summary Form, has been prepared and is attached to this RCL for EPA consideration.

6. Submission Date for Next Five Year Review – EPA acknowledges that in this 4th Five Year Review Report, there were events and activities that occurred after September 2012, the end of the period, and were important accomplishments (e.g., well verification to support the implementation and operation of land use controls) which supported protectiveness determinations. While EPA supports their inclusion, we suggest initiating the report preparation and associated activities (i.e., inspection & LUC activities) prior to the end of the report period to eliminate any confusion with regard to assessing a site with data collected after end period.

   For the next period of October 2012 to September 2017, we suggest beginning the five year review process March 2017 (or earlier) so that submission of the draft report would approximately fall by October 2017.

   For the Executive Summary, EPA suggests that a paragraph be added (to the previously recommended "Executive Summary") to explain that for some sites and/or groundwater plumes, data and/or information beyond the September 2012 end of period were evaluated in the five year review, and may affect the identification of issues, recommendations and follow-up actions. To alleviate having to rewrite sections, EPA recommends that the Recommendations section note if data and/or information after September 2012 was considered.

Response: Comment noted. As suggested in the comment, the Air Force will plan to start the preparation of the 5th Five Year Review (covering the period October 2012 through September 2017) around March 2017 with the goal of submitting a draft by approximately October 2017.

The Executive Summary narrative associated with the response to General Comment 5 and attached to this RCL explains that for some sites and/or groundwater plumes, data and/or information collected beyond September 2012 were evaluated for this Five Year Review. The sites where this is the case are listed in the Executive Summary narrative. In summary, the following source area site evaluations rely on data collected after September 2012: LF-1 (annual inspection completed in October 2012); FTA-2 (long-term monitoring groundwater sampling event completed in December 2012/January 2013); and LF-7 (annual inspection completed in October 2012). All groundwater sites with active treatment (AV, CS-4, CS-10, CS-20, CS-21, CS-23, FS-1, FS-12, FS-28, and LF-1) considered data and information collected after September 2012 since at a minimum, the system performance summaries presented in the data review sections of the groundwater narratives include mass removal and volume of groundwater treated metrics through December 2012. Information collected under AFCEC's LUC well verification program after September 2012 was considered in this Five Year Review at the CS-19, FS-13, FS-29, and SD-5 (as well as all the other groundwater plumes listed above). Therefore, information and/or data collected after September 2012 were considered in the development of the protectiveness statements for all the groundwater plumes presented in Section 5.0 of the Five Year Review.

7. Please add the following table to the document. This table contains information that assists EPA HQ review of the document with regard to sites that are present in our tracking system.

EPA CERCLIS OPERABLE UNIT NUMBER & DOCUMENT SECTION

OU#	SITE NAME	DOCUMENT SECTION
1	FS-12	5.9
2	CS-4	5.2
3	CS-3 (USCG)	na
4	CS-1 (USCG)	na
5	FTA-2/LF-2, PFSA/FS-10/FS-11, SD-2/ FS-6/FS-8, SD-3/FTA-3/CY-4, SD-4, and SD-5/FS-5	4.4, 4.6, 4.7
6	FS-1	5.8
7	LF-1 Landfill Cap	4.3
8	CS-10/FS-24 Source Area	4.1
9	Southwest Operable Unit	5.2, 5.5, 5.6, 5.10

10	FS-9	na
11	CS-16/CS-17	na
12	FS-17/FS-19	na
13	SD-5 North	5.14
14	CS-10 Sandwich Road	5.3
15	Ashumet Valley Groundwater	5.1
16	LF-1 Groundwater	5.13
17	Eastern Briarwood	na
18	Western Aquafarm	na
19	FS-28 & FS-29	5.11 & 5.12
20	SD-5 South	5.14
21	CS-10 In-Plume	5.3
22	CS-10 Southwest	5.3
23	FS-2	na
24	CS-19	5.4
25	CS-23	5.7

Response: A table containing the information provided in the comment will be incorporated into the Five Year Review as Table 1-6 (attached). The following sentence will be added to Section 1.8 (page 1-9):

"……source areas, and groundwater plumes, respectively. A matrix that cross references the EPA Comprehensive Environmental Response, Compensation, and Liability Information System (CERCLIS) Operable Unit Numbers to the IRP site names and document section is provided in Table 1-6. Appendix A includes a copy of newspaper announcement……."

SPECIFIC COMMENTS:

1. Page 2-3, Section 2.2, Paragraph 3, 1st Sentence – Change tense of sentence (i.e., change first "have" to "had" and delete 2nd "have").

   Response: The text will be revised as suggested.

2. Page 3-8, Section 3.5, Top of Page – No inspections for groundwater sites is alarming to the reader. In addition to operation & maintenance activities, EPA suggests adding to this text and state, if present, any significant issues associated with operation of treatment plants and/or extraction wells for groundwater remedies that inhibit operation at full capacity per the ROD and subsequent Project Notes for system operation are immediately reported to the regulatory agencies via operational status emails. If there is a treatment system that is not operating at its stated level by the completion of this report, it should be noted and a follow-up action should be generated.

Response: As described in Section 3.5, the groundwater site remedial systems are routinely inspected (daily during the work week) by AFCEC's O&M contractor and any operational or other issues such as operational downtime are reported to the regulatory agencies via operational status e-mails. Restart notifications are also provided via e-mail. The text will be revised as follows:

"Similar to prior Five Year Reviews, SIs for the 14 groundwater sites evaluated in this Five Year Review were not conducted because these sites, and the associated remedial systems for the plumes with active treatment, are routinely inspected (daily during the work week) as part of the ongoing O&M activities by AFCECs full-time O&M contractor. Any operational or other issues, such as operational downtime, are immediately reported to the regulatory agencies via operational status e-mails. Restart notifications are also provided via e-mail. The IRP remedial systems are operated………..”

In addition, Section 3.5 explains that operational performance is reported in the annual Summary Letter Reports. Based on a review of the data in these reports, and the monthly O&M reports, there are no significant issues associated with the operation of the remedial systems. Therefore, no further revisions to this section are required and no follow-up actions need to be generated.

3. Page 4-27, Section 4.2.7 – Suggest deleting #2 to keep document focused on actionable recommendation in #1 because #2 provides two options that are dependent on #1.

   Response: Concur. Item #2 on page 4-27, Section 4.2.7 will be deleted and the recommendation will also be removed from Table 1-4 (attached).

4. Page 4-41, Section 4.3.7 – Add finalization of LF-1 ESD as a follow-up action since it is mentioned in Section 4.3.4.

   Response: Since comment resolution on the LF-1 ESD has been completed and the final document has been submitted to the agencies for signature, AFCEC believes the Final LF-1 ESD will be issued prior to, or co-incident with this Five Year Review. Therefore, a recommendation to finalize the LF-1 ESD is not needed in Section 4.3.7. The Final ESD will be included in the references to this section.

5. Page 4-50, Section 4.4.3.1 – ROD for FTA-2/LF-2 included a source area-related action to document the landfill at LF-2 with the State, however this should be clarified to be an on-base land use control similar to LF-1.

Response: Since no deed exists for the parcel where LF-2 is located, AFCEC plans to meet the intent of MassDEP's solid waste regulation by filing a deed notification at the base real property office which will act as an on-base land use control. The following text will be added to Section 4.4.3.1:

"…………Therefore, UU/UE conditions have not been met and the institutional controls specified as part of the remedy are required to maintain protectiveness (AFCEE 2010a). In addition, a component of the institutional controls was to document the presence of a landfill at LF-2 through a deed notification per the MassDEP solid waste regulations (310 CMR 19.141). AFCEC, working with the base real estate office and the Commonwealth who owns the property, have been unable to determine whether a deed for this parcel is in existence. Therefore, the deed notification will be filed at the Base Real Property office which will meet the intent of the deed notification regulatory requirement……"

6. Page 4-57, Section 4.4.7 – Add clarification of source area land use control as mentioned in above comment on Section 4.4.3.1.

Response: See response to Comment 5 above. The following text will be added at the end of Section 4.4.7 and the item has been added to Table 1-4 (attached) as a recommendation:

"In addition, a component of the institutional controls was to document the presence of a landfill at LF-2 through a deed notification per the MassDEP solid waste regulations (310 CMR 19.141). AFCEC, working with the base real estate and the State who owns the property, have been unable to determine whether a deed for this parcel is in existence. Therefore, the deed notification will be filed at the Base Real Property office which will meet the intent of the deed notification regulatory requirement. This action will be documented in the ROD Amendment."

7. Page 4-66, Section 4.5.7 – Suggest revising to state that there are no issues with regard to the five year review and continued inspections and surveys would be conducted per the Decision Document. EPA holds that AFCEC has the authority to pursue additional investigation with the overall objective of achieving UU/UE for LF-7.

Response: Section 4.5.7 will be revised to read:

"There are no issues with regards to protectiveness at LF-7 and continued annual inspections and radiological surveys should be conducted per the Decision Document. AFCEC will continue to determine whether the site can reasonably meet UU/UE site closure requirements."

8. Page 5-16, Section 5.1.5.1, #2 – Please check if EDB mentioned in paragraph is correct. EPA does not recall that EDB is a known COC for Ashumet Valley.

   Response: Correct. The concentration ranges presented in this section are for PCE, the primary Ashumet Valley COC. The text will be revised to read:

   "The five highest PCE detections at AV in 2007 ranged from 18.2 to 34.6 µg/L. In 2012, the five highest PCE detections at AV ranged from 15 to 36 µg/L."

9. Page 5-41, Section 5.2.7 – Suggest clarifying the issue restating that 'current modeling projects cleanup after ROD predicted goal' so the recommendation would be to 'rerun the model similar to CS-20.' Please provide text in response to comment letter.

   Response: The first sentence in Section 5.2.7 will be revised to read:

   "Since current transport modeling projections predict a restoration timeframe (2029) beyond that predicted at the time of remedy selection (2017) and as discussed in Section 5.2.5.1, a modeling-based remedial system optimization assessment will be completed for the CS-4 plume."

10. Page 5-87, Section 5.5.1, 2000 – Edit to "ROD Finalized" instead of "Preparation of ROD."

    Response: The text will be revised as suggested.

11. Page 5-104, Section 5.6.1, 2000 - Edit to "ROD Finalized" instead of "Preparation of ROD."

    Response: The text will be revised as suggested.

12. Page 5-122, Section 5.7.1, 2007 - Edit to "ROD Finalized" instead of "Preparation of ROD."

    Response: The text will be revised as suggested.

13. Page 5-159, Section 5.9.1, 2006 – Edit to "ROD finalized" instead of "A ROD was submitted"

    Response: The text will be revised as suggested.

14. Page 5-172, Section 5.9.7 – EPA believes that the optimization assessment should not unilaterally lead into an ESD which updates the aquifer restoration timeframe to a date after the ROD predicted date. See General Comment 1.

    Response: AFCEC agrees that the optimization assessment should not unilaterally lead into an ESD which updates the aquifer restoration timeframe. AFCEC intends to continue with its established optimization process including working with EPA and MassDEP so remedial management decisions can be jointly made. AFCEC believes this process was effective on the recent CS-10 remedial system optimization evaluation where achieving the model-predicted system operation and aquifer restoration timeframes presented in the ROD were balanced with life-cycle cost analysis. The last sentence of the 2nd paragraph of Section 5.9.7 will be revised to read:

    "If necessary at the conclusion of the optimization assessment, an ESD presenting the updated CSM and/or the updated prediction for aquifer restoration timeframe should be completed for FS-12."

15. Page 5-221, Section 5.12.6.1, 3rd Sentence – Edit sentence to clearly state the period of action remediation at FS-29 (i.e., shutdown in 2010).

    Response: The 3rd sentence in Section 5.12.6.1 will be revised to read:

    "Through the combination of the treatment by the remedial system (between system startup in 2006 and shutdown in 2010) and natural attenuation processes, groundwater cleanup levels are expected to be achieved within the timeframe approximated in the ROD (i.e., 2014)."

16. Page 5-228, Section 5.13.2.1, 2007 - Edit to "ROD Finalized" instead of "Preparation of ROD."

    Response: The text will be revised as suggested.

17. Page 5-247, Section 5.13.7 - EPA believes that the optimization assessment should not unilaterally lead into an ESD which updates the aquifer restoration timeframe to a date after the ROD predicted date. See General Comment 1.

    Response: AFCEC agrees that the optimization assessment should not unilaterally lead into an ESD which updates the aquifer restoration timeframe. AFCEC intends to continue with its established optimization process including working with EPA and MassDEP so remedial management decisions can be jointly made. AFCEC believes this process was effective on the recent CS-10 remedial system optimization evaluation where achieving the model-predicted system operation and

aquifer restoration timeframes presented in the ROD were balanced with life-cycle cost analysis. The second to last sentence of the 2nd paragraph of Section 5.13.7 will be revised to read:

"If necessary at the conclusion of the optimization assessment, an ESD presenting the updated prediction for aquifer restoration timeframe will be completed."

18. Table 1-4, CS-10/FS-24, Recommendation/Follow-up Actions – Revise "reassess soil data and pursue UU/UE closure" to simply "Reassess Soil Data for UU/UE".

    Response: Table 1-4 (attached) has been revised as suggested.

19. Table 1-4, CY-2, Recommendation/Follow-up Actions – Revise to "Submit EE//CA and Action Memo for soil removal to achieve UU/UE"

    Response: Table 1-4 (attached) has been revised as suggested.

20. Table 1-4, LF-1 – Delete issue related to solar project since it is not approved. It is acceptable to leave mention of it in the body text.

    Response: The issue related to the solar project has been removed from Table 1-4 (attached).

21. Table 1-4, LF-1, Recommendation/Follow-up Actions – Revise to "Finalize ESD for LF-1"

    Response: Since comment resolution on the LF-1 ESD has been completed and the final document has been submitted to the agencies for signature, AFCEC believes the Final LF-1 ESD will be issued prior to, or co-incident with this Five Year Review. Therefore, a recommendation to finalize the LF-1 ESD is not needed in Table 1-4.

22, Table 1-4, FTA-2/LF-2, Issue Description – Add sub-issue for landfill to clarify source area land use control.

    Response: A sub-issue has been added to Table 1-4 (attached) to clarify the source area land use controls. Also see response to specific comment 7.

23. Table 1-4, FTA-2/LF-2, Recommendation//Follow-up Actions – Revise to "Submit Focused Feasibility Study" and for source area issue, add "Document clarification of land use control for LF-2 in ROD Amendment for groundwater."

    Response: Table 1-4 (attached) has been revised as suggested.

24. Table 1-4, LF-7 – Delete row in table since there is not currently an issue.

    Response: The row in Table 1-4 (attached) that addressed LF-7 has been deleted since there is no protectiveness issue.

25. Table 1-4, PFSA (FS-10/FS-11), Recommendation//Follow-up Actions, LUC/long-term Protectiveness – Simply actions to "Submit Focused Feasibility Study"

    Response: Table 1-4 (attached) has been revised as suggested.

26. Table 1-4, CS-4, Recommendation//Follow-up Actions – Suggest revising text to "Submit or present transport re-simulation"

    Response: The text in Table 1-4 (attached) has been revised to read:

    "Re-run transport simulation and present results".

27. Table 1-4, CS-10, Recommendation//Follow-up Actions – Since Focused Feasibility Study for CS-10 has been completed, suggest revising text to "Submit draft ESD to document optimization of treatment system"

    Response: Table 1-4 (attached) has been revised as suggested.

28. Table 1-4, FS-12, Recommendation/Follow-up Action Summary – Edit to include above comment on Section 5.9.7. Last sentence should express that the ESD, if necessary, will present the decision after the optimization assessment.

    Response: The last sentence of the text in this section of Table 1-4 (attached) has been revised to read:

    "If necessary at the conclusion of the optimization assessment, an ESD presenting the updated CSM and/or the updated prediction for aquifer restoration timeframe will be completed."

29. Table 1-4, LF-1, Recommendation/Follow-up Action Summary – Edit to include above comment on Section 5.13.7. Last sentence should express that the ESD, if necessary, will present the decision after the optimization assessment.

    Response: The last sentence of the text in this section of Table 1-4 (attached) has been revised to read:

"If necessary at the conclusion of the optimization assessment, an ESD presenting the updated prediction for aquifer restoration timeframe will be completed."

30. Appendix B – Include a summary table for site inspection issues identifying how and when they will/were be corrected, including party responsible, and stating if it will affect protectiveness.

<u>Response</u>: A summary table for site inspection issues has been prepared and reference to this site inspection summary table (Table 3-1, attached) will be added to Section 3.5. The first paragraph of Section 3.5 (page 3-7) will be revised to read:

"SIs have been completed for each of the source area sites addressed in Section 4.0 of this Five Year Review. A summary of the findings are included in each source area evaluation and completed SI forms are provided in Appendix B. In addition, Table 3-1 provides a summary of the site inspection findings, planned corrective actions including responsible party, and whether any issues affect protectiveness. It is noted that no issues were identified at any of the source area sites that required corrective action or affect protectiveness. Routine annual inspections required as part of the LUC programs at LF-1 and LF-7 will continue."

GENERAL COMMENT:

1. Throughout the Report, the AFCEC discusses changes to the carcinogenic toxicity values (oral and inhalation) and non-cancer toxicity values (oral and inhalation) for the chemicals of concern (COCs) trichloroethylene (TCE), tetrachloroethylene (PCE), and carbon tetrachloride (CCl_4), and characterizes these changes as resulting in either more or less conservative toxicity values for these COCs. The reference provided in the Report for these changes is the Integrated Risk Information System (IRIS) March 2013 data base. MassDEP notes that reference concentrations (RfCs) for inhalation toxicity were initially posted on IRIS for these COCs during the 5-year review period covered by the Report. The TCE RfC was posted on IRIS in September 2011, the PCE RfC was posted on IRIS in February 2012, and the CCl_4 RfC was posted on IRIS in March 2010. There were no previous RfCs for these compounds in the IRIS data base. Also, there was not a reference dose (RfD) for TCE in the IRIS data base prior to its initial posting in September 2011.

   MassDEP requests that a table be provided in the Report that indicates any changes to the carcinogenic toxicity values (oral and inhalation) and non-cancer toxicity values (oral and inhalation) for any of the chemicals of concern (COCs) for the IRP groundwater plumes at the MMR during the most recent 5-year review period. The table should indicate what the previous toxicity value was, what the current toxicity value is, and provide a reference for each toxicity value. Use of the current toxicity values will affect the outcome of any residual risk assessments performed as part of the three-step process to achieve site closure.

   Response: The existing narrative sufficiently addresses the five year review requirement to determine protectiveness. As mentioned in the comment, the current toxicity values will form the basis of future residual risk assessments; however, what is considered "current" at the time of this five year review may not be "current" at the time of the residual risk assessments. Thus, future residual risk assessments will refer to the appropriate published toxicity values at the time of the assessment as opposed to referring to the most current five year review.

2. Throughout the Report, the AFCEC indicates in the Section *Issues, Recommendations, and Follow-Up Actions* for each groundwater plume that the topic of emerging contaminants should be monitored as it relates to the groundwater plume. A study undertaken by the AFCEE and published in 2012, found that 1,4-dioxane is being identified at Air Force sites with groundwater contaminated with TCE. The study, titled **"Co-Occurrence of 1,4-Dioxane with Trichloroethylene in Chlorinated Solvent Groundwater Plumes at US Air Force Installations: Fact or Fiction,"** queried the USAF Environmental Restoration Program Information Management System (ERPIMS) for all relevant

records for groundwater monitoring wells with 1,4-dioxane, TCE and 1,1,1-trichloroethane (TCA). ERPIMS had records for 5,788 monitoring wells from 49 installations with analytical results for 1,4-dioxane, TCE and TCA. The study found that 1,4-dioxane was detected in 17.4% of the monitoring wells that had detections of TCE and/or TCA. This accounted for 93.7% of all 1,4-dioxane detections confirming that 1,4-dioxane is rarely detected independent of chlorinated solvent contamination.

The study indicated that 64.4% of all 1,4-dioxane detections were associated with TCE independent of any TCA detections demonstrating that 1,4-dioxane is a relatively common groundwater co-contaminant with TCE. The study recommends that site investigations consider 1,4-dioxane as a potential co-contaminant of TCE at groundwater plume sites. A query of the MMR VIEW database for 1,4-dioxane indicates that there has been very limited sampling for 1,4-dioxane in the groundwater at the MMR. MassDEP recommends that AFCEC develop a groundwater sampling plan for 1,4-dioxane at the MMR since TCE is a primary COC in several of the MMR IRP groundwater plumes. This recommendation should be incorporated into the Report as an emerging issue.

Response: AFCEC will add recommendations to the Five Year Review groundwater narratives to prepare a sampling and analysis plan for 1,4-dioxane at the following groundwater plumes/sites: Ashumet Valley, CS-4, CS-10, CS-20, CS-21, CS-23, LF-1, and SD-5. Specific text revisions are included in the response to EPA General Comment 3.

3. There is no final decision document or final record of decision for Coal Yard-2 (CY-2) and remedial action is needed at this site; therefore, CY-2 should be removed from this 5 year review.

   Response: CY-2 is being included in this Five Year Review in order to address the recommendations made in previous Five Year Reviews (the site has been included in previous Five Year Reviews). AFCEC believes that leaving the site in the current Five Year Review will contribute to maintaining a more complete narrative regarding this site. As a clarification, a no further action (NFA) Decision Document had been signed by MassDEP in 1988 (but no EPA signature). AFCEC (formerly AFCEE) and ANG before that had assumed the NFA Decision Document was fully executed and carried the site in its database as NFA. In February 2009, EPA examined their records and indicated that they did not sign the Decision Document due to insufficient data to make a NFA determination.

4. MassDEP recommends providing a section on community involvement in the Report. Please refer to the Community Involvement Plan Activities Matrix for the type of public information and involvement activities associated with 5 Year Reviews and provide a timeline for required activities.

   <u>Response</u>: A section on community involvement is included in the report as Section 1.6.3 which describes the public involvement activities associated with Five Year Reviews completed to date and planned. To date, AFCEC has placed public notices in the local newspapers and completed an MMRCT presentation on 09 January 2013 related to the commencement of this Five Year Review process. AFCEC plans a presentation of the findings of the Five Year Review at an MMRCT meeting tentatively scheduled for October 2013 following the submittal of the final Five Year Review report. In addition, AFCEC will prepare a fact sheet summarizing the findings of the Five Year Review which will be issued in Fall 2013. The following text will be added to the end of the past paragraph in Section 1.6.3:

   "In addition, AFCEC plans to prepare a fact sheet summarizing the findings of this Five Year Review for submittal in Fall 2013."

5. The Community Involvement Plan Activities Matrix does not specifically address community involvement activities associated with ESDs and ROD Amendments. For some sites the ROD has been in place for some time and MassDEP recommends a discussion to determine the appropriate community involvement requirement/s to inform and/or involve the public.

   <u>Response</u>: The May 2003 Community Involvement Plan Activities Matrix includes the CI activities associated with a ROD Amendment. The 2010 CI Plan Addendum added the CI activities associated with an ESD to the matrix. AFCEC currently includes post-ROD activities on the MMRCT agenda in the form of plume updates, but will be glad to further discuss CI opportunities with MassDEP. No changes to the Five Year Review are recommended in association with this comment.

6. Throughout the document the terms "stakeholder", "broad stakeholder group" and "interested parties" are used. Please use consistent language and include the MMR citizen advisory team.

   <u>Response</u>: The terms noted above are defined where they are used and apply to different group members. In the context of their use in the report, these groups do not specifically include the MMR citizen advisory team. No changes to the Five Year Review are recommended in association with this comment.

7. MassDEP suggests that the program schedule include timelines for activities associated with subsequent 5 year review reports so that it is clear required activities are tracked and the document reports on activities for the specific timeframe.

   Response: AFCEC does not maintain a program schedule of the kind MassDEP may be referring to in this comment (i.e., master schedule used to manage the program from groundwater RIs, through RODs and subsequent construction). To meet the intent of this comment (and others in this RCL), AFCEC will develop a tracking tool that can be used at the AFCEC-Regulator Technical Update Meetings to monitor progress and action items associated with the recommendations from this Five Year Review.

8. Please verify/identify timeframes for work to be completed, the deliverable that will document the activity, and a schedule for sites needing additional work.

   Response: Table 1-4 of the Five Year Review provides the requested information. Also see EPA General Comment 4.

9. For the next 5 year report MassDEP suggests that a comparison table(s) or narrative within the report be used to provide a status of activities suggested in the last 5 year review.

   Response: Per EPA Five Year Review Guidance, each of the site narratives presented in Section 4 (source areas) and Section 5 (groundwater plumes/sites) in this Five Year Review provide a section titled "Progress Since Last Five Year Review" which summarizes the progress made on the specific recommendations and follow up actions presented in the last Five Year Review. This approach will be taken in the next Five Year Review as well.

10. Throughout the document (e.g., the LUC info in Section 3.4, 3.5) the text states that AFCEC will work with EPA. Please also state that the AFCEC will work with MassDEP.

    Response: Since neither AFCEC nor EPA are specifically mentioned in Sections 3.4 or 3.5, and based on MassDEP's Page Specific Comments 3 and 4, we assume the comment is related to Section 3.3.2 (bottom of page 3-4). The narrative in this section presents verbatim language from the ROD describing how the Air Force, in consultation with EPA will implement the private well verification process. As has been demonstrated for many years under this cleanup program, it is AFCEC's intent to work with both EPA and MassDEP and make remedial management decisions jointly. For the purposes of this Five Year Review, the subject text in Section 3.3.2 will be revised to read:

"Within three years of the signing of the ROD or ESD, the Air Force shall:

a. Document all private wells (i.e., non-decommissioned wells, including wells not currently in use) that are above or within the projected path of the plume(s).

b. Demonstrate and document that the private well is not capable of drawing contaminated groundwater originating from the plume(s), or test the private well for contamination and demonstrate the private well to be safe for human use. The Air Force will continue such testing, on an appropriate frequency as determined in coordination with the EPA (and MassDEP), until the plume(s) no longer presents a threat to that well as determined in coordination with EPA and MassDEP.

c. If the Air Force identifies a well containing contaminants of concern (COCs), the Air Force shall assess the risk that current and potential future non-drinking uses of the well may pose to human health. The Air Force shall submit a draft version of any such risk assessment to EPA and MassDEP for review and concurrence.

d. If neither b nor c is able to confirm that the identified well is safe for human use, the Air Force will offer the owner decommissioning of the well. If accepted, the Air Force will document such action with the appropriate BOH. If the decommissioning is not accepted, the Air Force will take other steps to insure protectiveness to include, but not be limited to, requesting assistance from the appropriate BOH to issue health warnings to the property owner and any other person with access to the well (such as a lessee or licensee), offering bottled water (if well is used for drinking), or installing treatment systems on affected wells. In each instance, the Air Force shall submit a schedule subject to EPA and MassDEP concurrence, outlining and including time limitations for the completion of steps sufficient to prevent exposure to concentrations of contaminated groundwater from the plume(s) having carcinogens in excess of applicable or relevant and appropriate requirements (ARARs) (i.e., MCLs, non-zero MCL goals), and prevent exposure to groundwater from the plume(s) that poses a cancer risk in excess of the EPA target risk range of 10^{-4} to 10^{-6} or which presents a non-carcinogenic hazard index greater than one."

11. Please include an appropriate statement which characterizes the status of the program such as **"The LUCs are in place and are functioning as intended"** for all sites with ongoing LUC programs.

    <u>Response</u>: Each of the protectiveness statements in the site narratives, as summarized in Table 1-5, include the statement "The LUCs are in place and are functioning as intended" where LUCs are an element of the remedy with the exception of FTA-2/LF-2 and LF-7.

    For FTA-2/LF-2, the protectiveness statement (Section 4.4.8, page 4-58) states "The remedy is protective in the short-term since access to the site is controlled by current flight line security measures which include fencing and 24-hour security that effectively limits potential human exposure to site contaminants"; a recommendation to place an on-base land use control to meet the intent of the notification requirements of MassDEP solid waste regulations has been included in this Five Year Review – see response to EPA Specific Comment 5.

    For LF-7, the protectiveness statement in Section 4.5.8 (page 4-67) and Table 1-5 (attached) will be revised to read:

    "The LUCS (i.e., fence and signage) at LF-7 are in place and functioning as intended…."

12. The use of the pounds of contaminant mass removed measurement is used throughout the document. MassDEP suggests using 'millions of gallons treated' as well or instead of the mass removal figure.

    <u>Response</u>: Remedial system performance metrics (mass removal and volume treated) are reported in the data review sections of the groundwater plume narratives. Volume of groundwater treated (in millions or billions of gallons) since system startup and during this Five Year Review period is reported along with contaminant mass removal in pounds over the same periods.

13. The terminology "the topic of emerging contaminants should be monitored as it relates to groundwater at ..." should be included for all sites where TCE is a COC.

    <u>Response</u>: The statement "the topic of emerging contaminants should be monitored as it relates to groundwater at ..." is included for all sites where TCE is a COC. Also see response to EPA General Comment 3 and MassDEP General Comment 2.

PAGE-SPECIFIC COMMENTS:

1. Page 1 -5, Section 1.6, ADMINISTRATIVE AND GLOBAL COMPONENTS OF FIVE YEAR REVIEW PROCESS:
The AFCEC indicates, **"Under EPA policy, if cleanup at a site is deferred to a corrective action order under another statute (such as the Resource Conservation and Recovery Act [RCRA] or the Safe Drinking Water Act), it is not necessary to conduct a Five Year Review. Therefore, the contaminated sites at MMR that are being cleaned up by the MMR Impact Area Ground Water Study Program (IAGWSP), pursuant to the EPA Region 1 Administrative Order, under the authority of the Safe Drinking Water Act, are not included in this report. It should be noted, however, that a separate Five Year Review was conducted by the IAGWSP for their sites in 2013."** It is not clear why the Impact Area activities are mentioned in this AFCEC report. Please clarify/delete.

Response: As there are two major cleanup programs operating at the MMR and both create separate five year reviews, AFCEC believes this language should be retained as it helps the reader understand that the subject review does not address the work being conducted under the IAGWSP.

2. Page 2 -1, Section 2.1, SITE LOCATION AND DESCRIPTION:
The text states that **"Camp Edwards is located on the 5,000 acre Cantonment Area".** Please correct the text.

Response: To clarify that a portion of Camp Edwards is located on the Cantonment Area, the first 2 bullets in Section 2.1 (page 2-1) will be revised to read:

- **Range Maneuver and Impact Area.** This area consists of approximately 16,000 acres occupying the northern 70 percent of MMR and is used for training and maneuvers as part of the Army National Guard's (ARNG) Camp Edwards.

- **Cantonment Area.** This area consists of approximately 5,000 acres in the southern portion of MMR and is the location for all or part of the administrative, operational, maintenance, housing, and support facilities and the flightline for Otis ANG Base, U.S. Coast Guard (USCG) Air Station Cape Cod, and Camp Edwards.

3. Page 3-4, Section 3.3.2, Land Use Control Requirement for IRP Groundwater Sites:
The Report states, **"Demonstrate and document that the private well is not capable of drawing contaminated groundwater originating from the plume(s), or test the private well for contamination and demonstrate the private well to be safe for human use. The Air Force will continue such testing, on an appropriate frequency as determined in coordination with the EPA,"** Please add "and the MassDEP" **until the plume(s) no longer presents a threat to that well as determined in coordination with EPA** "and MassDEP".

Response: See response to MassDEP General Comment 10.

4. Page 3 -4, Section 3.3.2, Land Use Control Requirement for IRP Groundwater Sites:
The AFCEC indicates, **"If the Air Force identifies well containing contaminants of concern (COCs), the Air Force shall assess the risk that current and potential future non-drinking uses of the well may pose to human health. The Air Force shall submit a draft version of any such risk assessment to EPA for review and concurrence."** Please add "and MassDEP" for review and concurrence.

Response: See response to MassDEP General Comment 10.

5. Pages 3-6 and 3-7, Section 3.3.2, Land Use Control Requirement for IRP Groundwater Sites:
MassDEP recommends the yearly LUC reports be attached to 5 year review reports.

Response: The annual LUC evaluation reports prepared by AFCEC per the LUC requirements in the RODs will be appended to future Five Year Review reports.

6. Page 3-8, Section 3.6, INTERVIEWS:
The AFCEC indicates, **"Similar to the last Five Year Review (AFCEE 2008a) and with concurrence from EPA"**; Add "and MassDEP."

Response: AFCEC records indicate that the subject of site interviews was only discussed with EPA as AFCEC was clarifying the intent of the interviews associated with EPA's Five Year Review guidance.

7. Page 4-1, Section 4. 0, SOURCE AREAS REQUIRING FIVE-YEAR REVIEW:
The Report states, **"This section presents the source area sites for which a Five Year Review is required." Seven sites (Table 1-2) require a Five Year Review because of one of the following conditions: remedial actions are underway**

(CY-2)"; Please remove CY-2 as the site does not have a remedial action in place. In addition the text states **"additional investigative work has been completed during this Five Year Review period that indicates further evaluation and/or remedial actions are required (CS-10/FTA-2/PFSA)".** Please indicate what CERCLA document will report this additional investigative work.

Response: See MassDEP General Comment 3 regarding CY-2. The additional investigative work at CS-10/FTA-2/PFSA mentioned in this comment has already been completed and documented as cited in this Five Year Review and tabulated in Tables 4-1, 4-2, and 4-3.

8. Page 4-16,Section 4.1.7, Issues, Recommendations, and Follow-Up Actions:
The AFCEC recommends, **"Complete a reassessment of Detail C EPH/VPH data and Detail F PAH, PCB, inorganic data and pursue UU/UE closure; however, if this cannot be achieved, then pursue a LUC which would be documented in an ESD."** Please state how this type of activity and public comment period will be tracked in the overall schedule.

Response: If an ESD is required, AFCEC will apply the CI activities included in the March 2010 Community Involvement Plan Addendum (or subsequent updates). Additionally, AFCEC will develop a tracking tool that can be used at the AFCEC-Regulator Technical Update Meetings to monitor progress and action items associated with the recommendations from this five year review.

9. Page 4-1 6, Section 4.1.8, Protectiveness Statement:
The AFCEC indicates, **"The remedies for CS-10/FS-24 source area Details C and F are protective of human health and the environment in the short-term under the current land use scenario. However, for the remedies to be protective in the long-term it is recommended that existing site characterization data be re-evaluated to determine if UU/UE conditions have been met; if UU/UE closure cannot be supported for Details C and/or F, then either (i) conduct additional cleanup activities to levels that allow UU/UE; or (ii) issue a decision document implementing enforceable LUCs preventing uses for which the site may still pose an unacceptable risk under future uses that would ensure long-term protectiveness."** Please state how this type of activity and public comment period will be tracked in the overall schedule.

Response: If an ESD is required, AFCEC will apply the CI activities included in the March 2010 Community Involvement Plan Addendum (or subsequent updates). Additionally, AFCEC will develop a tracking tool that can be used at the AFCEC-Regulator Technical Update Meetings to monitor progress and action items associated with the recommendations from this five year review.

10. Page 4-25, Section 4.2.5.1, Data Review:
This section indicates that soil removal has not been completed. Please state when this activity was recommended and if it was a recommendation from the last 5 year report. Please indicate a timeframe for this activity to be completed.

Response: The third five year review recommended additional cleanup to levels that allow for unlimited use and unrestricted exposure (Section 3.6.18.F(2)). AFCEC will issue an EE/CA and Action Memorandum before any further work is conducted. As indicated in revised Table 1-4 (attached), preparation of the EE/CA will begin in November 2013. The soil removal is estimated to be completed in Summer 2014.

11. Page 4-26, 4.2.7 Issues, Recommendations, and Follow-Up Actions:
The text states **"1. In order to document the significant removal action work completed at CY-2 and the remaining work planned with the objective of achieving UU/UE closure, in accordance with the NCP (40 CFR 300.415(b)(4)(i)) and *Guidance on Conducting Non-Time-Critical Removal Actions Under CERCLA* (EPA/540-R-93-057), AFCEC will prepare an Engineering Evaluation/ Cost Assessment(EE/CA). The EE/CA will establish RAOs, identify ARARs, evaluate cost effective removal alternatives, and recommend a preferred removal alternative. The EE/CA will present removal action work conducted to date as background, and the remaining work necessary to complete the non-time-critical removal action for CY-2".** The 5 year review requirement applies to all remedial actions selected under CERCLA §121. There is not a final Decision Document or Record of Decision for Coal Yard (CY) 2. In addition the extent of arsenic contamination has not been fully delineated and soil remedial action is needed. Therefore, MassDEP recommends removing CY-2 from this 5 year review. Please inform MassDEP of the date when the NTCRA commenced and its associated timeline for removal activities. The Community Involvement Plan Activities Matrix notes that for all NTCRAs a news release and newspaper ad is warranted to alert the public of a 30 public comment period. Please clarify if this community involvement activity has occurred. In addition AFCEC states **"that all AFCEC source areas are complete"**. This statement is incorrect. Please delete.

Response: Please see MassDEP General Comment 3 regarding removal of CY-2 from the five year review. An NTCRA has not yet been declared for CY-2. AFCEC did proceed with removing coal piles (that had been likely moved to the area when the coal storage yard was closed) from the site in May 2012. No CI activities associated with the coal pile removal were conducted. Further sampling and soil removal will be required for the site to achieve closure and will be conducted as part of an EE/CA, AM, NTCRA with appropriate CI activities per the Community Involvement Plan. The statement **"…….that all AFCEC source**

areas are complete" is not specifically mentioned in the five year review and AFCEC assumes MassDEP is referring to this statement in a general sense. AFCEC concurs that this statement should not be included in briefings, CI products, etc., as AFCEC is now attempting to achieve unlimited use/unrestricted exposure status for its source areas wherever reasonably feasible.

12. Page 4-56, Section 4.4.6.2, Question B: Are the exposure assumptions, toxicity data, cleanup level, and RAOs used at the time of remedy selection still valid?: The AFCEC indicates, **"However, the groundwater media was not directly considered at the time of the remedy selection, therefore the groundwater exposure pathway should be further evaluated based on the recent history of groundwater monitoring data."** Please provide a timeframe and associated document and indicate how this evaluation will be tracked and/or factored into the overall schedule.

    Response: AFCEC will develop a tracking tool that can be used at the AFCEC-Regulator Technical Update Meetings to monitor progress and action items associated with the recommendations from this Five Year Review.

13. Page 4-57, Section 4.4.6.3, Question C: Has any other information come to light that could call into question the protectiveness of the remedy?: **"The petroleum hydrocarbon contamination (e.g., EPH/VPH, TMB isomers, and 2-methylnapthalene) that has been identified in groundwater above groundwater standards and/or RBCs (Table 4-2) requires that further remedial actions are necessary since RAOs directly related to groundwater are not included in the ROD."** Please provide a timeframe and associated document, indicate how this evaluation will be tracked and/or factored into the overall schedule and if it would necessitate an ESD.

    Response: AFCEC will develop a tracking tool that can be used at the AFCEC-Regulator Technical Update Meetings to monitor progress and action items associated with the recommendations from this Five Year Review.

14. Page 4-57, Section 4.4.7, Issues, Recommendations, and Follow-Up Actions: Please indicate timeframe, tracking, schedule for the focused feasibility study for FTA-2.

    Response: AFCEC will develop a tracking tool that can be used at the AFCEC-Regulator Technical Update Meetings to monitor progress and action items associated with the recommendations from this Five Year Review.

15. Page 4-97, Section 4.7.5.1. Data Review:
The Report indicates, **"The results of the July 2012 resampling at three sediment sample locations confirm that inorganic compounds (arsenic, cadmium, total chromium, and nickel) remain in the pond/wetland area at concentrations above human health screening levels and lead remains above background. Therefore, the data do not support UU/UE in this area. Institutional controls are required at SD-4 specifically for the pond/wetland area (south of Reilly Road) for the remedy to be protective of human health in the long-term. These institutional controls will be added to the remedy through the preparation of an ESD."** Please include a table or schedule for all recommendations (ESD) as part of this 5 yr. review.

Response: Table 1-4 was included in the report for this purpose. Also see MassDEP General Comment 8.

16. Page 5-7, Section 5. 1.2.3, Initial Responses CERCLA Actions:
The AFCEC indicates, **"The TRET established in 1996 as part of a new IROD management process, reviewed wellfield designs and determined that the 60-percent design for containment of several of the IROD plumes would cause negative ecological impacts (TRET 1996)."** Please define the TRET as a previous technical community advisory team.

Response: The TRET is first mentioned in Section 5.1.2.3 "Initial Responses" on page 5-5. Therefore, a description of the TRET as an advisory team will be added to the 3rd sentence of the 2nd paragraph (that starts "1998:") on page 5-5 as follows:

"AFCEE, in conjunction with the Technical Review and Evaluation Team (TRET), a prior technical and community advisory panel, convened several forums in which local and state experts……"

17. Page 5-15, Section 5.1.5.1, Data Review:
The Report states, **"The SLRs are provided to the broad stakeholder group for each plume including Federal (EPA) and State (MassDEP, MassDPH) regulatory agencies, town departments (such as the BOHs, Departments of Public Work, Water Departments, and/or Conservation Commissions), affected property owners, and other interested parties."** Please include the MMR citizen advisory team.

Response: The MMR citizen advisory team is not included in the distribution of the Summary Letter Reports. Also see MassDEP General Comment 6.

18. Page 5-16, Section 5.1.5.1, Data Review:
The AFCEC states, **"The five highest ethylene dibromide (EDB) detections at AV in 2007 ranged from 18.2 to 34.6 ug/L. In 2012, the five highest EDB detections at AV ranged from 15 to 36 ug/L."** Please revise the text by replacing EDB with PCE since EDB is not a COC for the Ashumet Valley groundwater plume.

Response: Concur. The concentration ranges presented in this section are for PCE, the primary Ashumet Valley COC. The text will be revised to read:

"The five highest PCE detections at AV in 2007 ranged from 18.2 to 34.6 µg/L. In 2012, the five highest PCE detections at AV ranged from 15 to 36 µg/L."

19. Page 5-22, Section 5.1.7 Issues, Recommendations, and Follow-Up Actions:
The AFCEC indicates, **"No specific recommendation or follow-up actions have been identified. However, the topic of emerging contaminants should be monitored as it relates to groundwater at AV and the MMR."** Please put the topic of emerging contaminant on a table for sites where this should be considered for ease in reviewing recommendations for the next 5 year review.

Response: The recommendation to monitoring the topic of emerging contaminants has been included for all the IRP groundwater sites presented in Section 5 of the Five Year Review. In addition, based on comments from both EPA and MassDEP, Table 1-4 "Issue Description and Recommendations/Follow-Up Actions" has been revised to include the specific sites where sampling and analysis plans should be developed for 1,4-dioxane and perfluorinated compounds. Refer to the response to EPA General Comment 3 for more details. A revised version of Table 1-4 is attached to this RCL.

20. Page 5-35, Section 5.2.5.1, Data Review:
The AFCEC states, **"The SLRs are provided to the broad stakeholder group for each plume including Federal (EPA) and State (MassDEP, MassDPH) regulatory agencies, town departments (such as the BOHs, Departments of Public Work, Water Departments, and/or Conservation Commissions), affected property owners, and other interested parties."** Please include the MMR citizen advisory group.

Response: The MMR citizen advisory team is not included in the distribution of the Summary Letter Reports. Also see MassDEP General Comment 6.

21. Page 5-75, Section 5.4.2.2, Physical Characteristics, Land and Resource Use:
The AFCEC indicates, **"The footprint of the CS-19 plume was approximately 18 acres in 2007, and was approximately 64 acres in 2012 (Figure 5-4B)."**

MassDEP recommends changing the figure reference to Figure 5-4A since this is the figure with the 2007 and 2012 CS-19 plume boundary comparison.

Response: Concur. The text will be revised to reference Figure 5-4A as suggested.

22. Page 5-107, Section 5.6.3, Remedial Actions:
The AFCEC states in regard to the CS-21 groundwater plume RAOs, **"Restore useable groundwaters to their beneficial uses wherever practicable, within a timeframe that is reasonable given the particular circumstances of the site."** Please confirm that RAO language presented for all sites in the Report is correct.

Response: The RAO language for all sites in the Five Year Review report is correct. AFCEC notes that a component of the 2011 *Final Explanation of Significant Differences for the Installation Restoration Program Groundwater Plumes at the Massachusetts Military Reservation* was to adjust the phrasing of the RAOs for consistency across all the groundwater sites. For CS-21, the RAO related to aquifer restoration was revised from "Restore the aquifer to its beneficial uses within a reasonable time" (from the 2000 ROD) to "Restore useable groundwaters to their beneficial uses wherever practicable, within a timeframe that is reasonable given the particular circumstances of the site." Table 3-2 in the 2011 ESD details the RAO phrasing changes by groundwater site.

23. Page 5-134, Section 5.7.7, Issues, Recommendations, and Follow-Up Actions:
The TCE concentration in CS-23 monitoring well 69MW1710A increased from 4.2 µg/L in June 2011 to 12 µg/L in May 2012. This is the first time a MCL exceedance of TCE was detected in this well, which is located approximately one-half mile downgradient from the currently depicted leading edge of the CS-23 plume. The TCE detection in this well is the result of contaminant mass already present in the aquifer downgradient of the CS-23 extraction wells when they began operating in December 2006. The TCE detection at a concentration above the MCL in monitoring well 69MW1710A prompted the AFCEC to perform a preliminary Land Use Control (LUC) assessment in this area. The preliminary LUC assessment indicated that the closest residential property is located approximately 1,000 feet downgradient of monitoring well 69MW1710A and that all properties downgradient and within 3,000 feet of monitoring well 69MW1710A have water accounts with the town of Falmouth.

A Project Note entitled *LF-1/CS-23 2012 ANNUAL SPEIM DATA PRESENTATION* was issued stating that the CS-23 plume/LUC boundary will be reassessed based on the results of next annual sample event in June 2013. Please indicate in the Report that a reevaluation of the CS-23 plume/LUC boundary is pending the results of June 2013 sampling event. A detection of TCE at a

concentration above the MCL in monitoring well 69MW1710A in June 2013 would result in a significant expansion of the CS-23 plume/LUC boundary.

Response: Comment noted. The following text will be added to Section 5.7.7 and the recommendation will be added to Table 1-4 (attached):

"A re-evaluation of the extent of the CS-23 plume and LUC area should be completed based on the increase in TCE concentration at monitoring well 69MW1710A which is located hydraulically downgradient of the CS-23 remedial system extraction wells."

24. Page 5-161, Section 5.9.2.3, Initial Responses, Non-CERCLA Actions:
The Report indicates, **"Private residences and the nearby summer camp that are located in the vicinity of the FS-12 plume were connected to the municipal water supply."** Since this activity is not considered a CERCLA action, please state under what authority the actions were conducted.

Response: The action was not required as part of a CERCLA decision document (which is why it is included in the "Non-CERCLA Action" section). The funding for the action did come from the Army Environmental Restoration Account which derives its authority from CERCLA.

25. Page 5-172, Section 5.9.7, Issues, Recommendations, and Follow-Up Actions:
The AFCEC recommends, **"An ESD presenting the updated CSM and the updated prediction for aquifer restoration timeframe should be completed for FS-12."** Please provide a schedule for this recommendation.

Response: Please see revised Table 1-4 (attached) and response to EPA General Comment 4.

26. Page 5-212, Section 5.12.2.3, Initial Responses, CERCLA Actions:
The AFCEC states, **"An ESD was submitted in 2008 to document changes to the selected remedy for FS-29 (AFCEE 2008b).** Please add the LUC private well verification program in the next paragraph where the inclusion of MNA language appears.

Response: The LUC private well verification program was included in the 2008 *Final Explanation of Significant Differences for Chemical Spill-4, Chemical Spill-20, Chemical Spill-21, Fuel Spill-13, Fuel Spill-28, and Fuel Spill-29 Groundwater Plumes*; the next paragraph in the subject section refers to the changes documented in the 2011 *Final Explanation of Significant Differences for the Installation Restoration Program Groundwater Plumes at the Massachusetts Military Reservation* which included the addition of the MNA language.

The first sentence on page 5-212 will be revised to read:

"An ESD was submitted in 2008 to document changes to the remedy for FS-29 (AFCEE 2008b) including the wellfield design/cleanup strategy; the ESD also further described the institutional controls (i.e., the private well verification program)."

27. Page 5-212, Section 5.12.2.3, Initial Responses, CERCLA Actions:
The Report states, **"An ESD for the IRP groundwater plumes was submitted in September 2011 that clarified the inclusion of MNA as a component of the selected remedy, slightly modified the phrasing of the RAOs, and updated the steps to achieve site closure (i.e., the three-step process) (AFCEE 2011a)."** Please add "and the ESD provided a more thorough description of the LUC program, including the details of the private well verification program."

Response: The 2011 ESD did not provide further details of the private well verification program for FS-29; this was included in the 2008 ESD as explained in the response to Comment 26 above. The 2011 ESD did revise the LUCs through the addition of the private well verification requirement but only for the FS-1, FS-12, and SD-5 groundwater plumes.

28. Page 2-5-247, Section 5.13.7, Issues, Recommendations, and Follow-Up Actions:
Please include information on the private well verification efforts.

Response: The private well verification efforts at LF-1 are described on page 5-236 in Section 5.13.3.1 "Remedy Selection and Implementation". Private well verification information is presented in this same section in all the groundwater plumes narrative in Section 5 of the Five Year Review. Therefore, for consistency, this information should not be added to the Issues, Recommendations, and Follow-Up Actions section for the LF-1 narrative.

29. Page 5-265, Section 5.14.7, Issues, Recommendations, and Follow-Up Actions:
The AFCEC indicates, **"An ESD should be prepared to update the aquifer restoration timeframe estimate for SD-5S."** Please indicate how these activities are tracked and provide the associated schedule.

Response: Please see revised Table 1-4 (attached) and response to EPA General Comment 4. AFCEC will develop a tracking tool that can be used at the AFCEC-Regulator Technical Update Meetings to monitor progress and action items associated with the recommendations from this Five Year Review.

30. Appendix B, Source Area Site Inspection Reports:
The site inspection checklists provided in Appendix B appear to be incomplete. Please incorporate recent efforts conducted associated with LUC activities.

Response: Per e-mail with MassDEP dated 17 September 2013, this comment can be deleted.

31. Appendix D, Technical Evaluations in Support of Land Use Control Program:
AFCEC MMR Land Use Controls Parcel Summary Reports, (FS-28), 74 Round Pond Drive, Falmouth MA, Parcel ID # 43579: Please update the checklist to reflect recent contact/communications, field visit, etc., to sample the well. In the associated data table please reference page number associated with groundwater profiling data.

Response: The AFCEC MMR Land Use Controls Parcel Summary Report will be updated as suggested to reflect the recent contact, communications, and sampling information. The groundwater vertical profiling data used to support the well determination is identified as the “WA” matrix in the accompanying data table. The explanation that the “WA” matrix is groundwater profiling data is contained in the key. Note that the “WG” matrix represents a groundwater sample collected from a monitoring well and data from these types of samples are also summarized in the data table.

EXECUTIVE SUMMARY

The U.S. Air Force conducted a Five Year Review of the remedies implemented at the Installation Restoration Program sites at the Massachusetts Military Reservation Superfund Site, located on western Cape Cod in Barnstable County, Massachusetts. The sites were reviewed because hazardous substances, pollutants, or contaminants remaining at one or more of the sites are above levels that allow for unlimited use and unrestricted exposure. The purpose of the five-year review is to determine whether the remedial actions implemented at each site remain protective of human health and the environment. In total, seven source area sites (Section 4.0) and 14 groundwater plumes/sites (Section 5.0) were assessed in this Five Year Review.

The remedies at two of the seven source area sites (Landfill-1 and Landfill-7) are considered protective of human health and the environment due to the implemented remedial actions. The remedies for the remaining five source area sites evaluated in this Five Year Review are protective of human health and the environment in the short-term based on current land use. Actions related to the implementation of land use controls and/or completion of exposure assessments related to vapor intrusion are recommended for the remedies at these sites for them to be protective in the long term.

The remedies at all 14 groundwater sites evaluated in this Five Year Review are considered protective of human health and the environment due to the implemented remedial actions including the full implementation of the land use controls which occurred during this five year review period. The primary actions recommended for the groundwater plumes/sites are related to assessment of emerging contaminants and further evaluation of restoration timeframe discrepancies between current projections and the expectations at the time of the completion of the Records of Decision. An abbreviated summary of the issues and recommendations/follow up actions for the source area and groundwater plume/sites evaluated in this Five Year Review are included in the Five Year Review Summary Form at the end of this Executive Summary. More detailed summaries of the recommendations/follow up actions are included in Table 1-4 and detailed descriptions are included in each of the site/plume specific narratives in Sections 4.0 and 5.0. A summary of the protectiveness statements for all the source area sites and groundwater plumes/sites is included in Table 1-5.

The triggering action for the statutory Five Year Review process for the Massachusetts Military Reservation Superfund Site began with the initiation of the remedial action on-site construction

date of the Chemical Spill-4 treatment system on October 15, 1992. As a result of this triggering action, the first Five Year Review, covering the period 1992-1997, was published in March 1999. Subsequently, the second and third Five Year Reviews, covering the periods 1998-2002 and 2002-2007 were published in May 2003 and September 2008, respectively. This is the fourth Five Year Review for the Massachusetts Military Reservation Superfund Site and covers the period from October 2007 through September 2012. However, for some source area sites and all the groundwater sites, data and information collected after September 2012 were considered in the development of the recommendation, follow up actions, and protectiveness determinations. The following source area sites rely on data and/or information collected after September 2012: Landfill-1 (annual landfill inspection completed in October 2012); Fire Training Area-2 (long-term monitoring groundwater sampling event completed in December 2012/January 2013); and Landfill-7 (annual landfill inspection completed in October 2012). For the groundwater plumes/sites, remedial system performance monitoring data was considered through December 2012; and data/information collected post-September 2012 under the Land Use Control Private Well Verification Program was paramount in the development of the protectiveness determinations.

Prior to the selection of a remedy, remedial investigations and assessments of the nature and extent of contamination were conducted. Based on the results of these investigations, remedial action objectives were selected for each Installation Restoration Program site. These objectives were then used to select the remedial actions for the site that are detailed in site-specific decision documents. During the five year review, the selected action is reviewed for its continued ability to achieve its goal of protection of human health and the environment, implementation, and system operation and maintenance (if applicable). For the Coal Yard-2 source area site, a decision document has not yet been finalized and therefore no remedial action objectives are in place. Protectiveness at this site was based on an evaluation of the current site condition and the ongoing remedial actions that are intended to allow for unlimited use and unrestricted exposure.

Data and information collected since the last Five Year Review were reviewed against the remedial action objectives for each site, trends in contaminant concentrations, changes in contaminant distribution, remedial system performance at sites with active treatment, land use, and status and performance of institutional controls.

FIVE-YEAR REVIEW SUMMARY FORM

SITE IDENTIFICATION		
Site Name: Massachusetts Military Reservation Superfund Site		
EPA ID: MA2570024487		
Region: 1	**State:** MA	**City/County:** Barnstable County

SITE STATUS	
NPL Status: Final	
Multiple OUs? Yes	**Has the site achieved construction completion?** Yes

REVIEW STATUS
Lead agency: Other Federal Agency **If "Other Federal Agency" was selected above, enter Agency name:** U.S. Air Force
Author name: Various – Refer to Section 1.3
Author affiliation: CH2M HILL
Review period: 01 October 2007 – 30 September 2012
Date of site inspection: 19 June 2013 and 10 July 2013
Type of review: Statutory
Review number: 4
Triggering action date: September 2008 (submittal date of Third Five Year Review)
Due date *(five years after triggering action date)*: September 2013

Issues/Recommendations
OU(s) without Issues/Recommendations Identified in the Five-Year Review:
Source Area Sites: LF-1, LF-7; Groundwater Sites: CS-19, FS-1, FS-13, FS-28, FS-29
Issues and Recommendations Identified in the Five-Year Review:
See following table for abbreviated summary of issues and recommendations by site and Table 1-4 for a detailed summary by site.

FIVE-YEAR REVIEW SUMMARY FORM

Site Name	Issue Description	Recommendation/ Follow-Up Actions
Source Area Sites		
CS-10/FS-24 Detail C and F	LUC/long-term protectiveness	Reassess soil data for UU/UE.
	Exposure assessment	Complete VI evaluation
CY-2	LUC/long-term protectiveness	Submit EE/CA and Action Memorandum for soil removal to achieve UU/UE
FTA-2/LF-2	LUC/long-term protectiveness	Submit Focused Feasibility Study
	LUC/long-term protectiveness	File deed notification and document in ROD Amendment
PFSA (FS-10/FS-11)	LUC/long-term protectiveness	Submit Focused Feasibility Study
	Exposure assessment	Complete VI evaluation.
SD-4	LUC/long term protectiveness	Prepare a RAR and ESD
	Exposure assessment	Complete VI evaluation
Groundwater Sites		
Ashumet Valley, CS-4, CS-10, CS-20, CS-21, CS-23, LF-1, and SD-5	Emerging contaminants	Develop sampling and analysis plan
CS-4	Restoration timeframe discrepancy	Re-run transport simulation and present results
CS-10	Restoration timeframe discrepancy	Submit draft ESD to document optimization of treatment system
FS-12	Restoration timeframe discrepancy	Update EDB plume shell and complete a remedial system optimization assessment
LF-1/CS-23	Restoration timeframe discrepancy	Update plume shells and complete a remedial system optimization assessment
	Increasing TCE concentration at CS-23 monitoring well	Re-assess plume boundary and LUC boundary and present results
	Potential ecological impacts from system operation	Continue monitoring
SD-5	Restoration timeframe discrepancy	Prepare an ESD

FIVE-YEAR REVIEW SUMMARY FORM

Protectiveness Statement(s)	
See Table 1-5 for Protectiveness Statements by site	
Site wide Protectiveness Statement (if applicable)	
For sites that have achieved construction completion, enter a site wide protectiveness determination and statement.	
Protectiveness Determination: Protective/Short-term Protective	*Addendum Due Date (if applicable):* Not applicable
Protectiveness Statement: Site wide, the remedies are either protective or short-term protective – see Table 1-5 for a summary by site.	

Table 1-4
Issue Description and Recommendations/Follow-Up Actions
Final 4th Five-Year Review, 2007-2012

Site Name	Issue Description	Issue Summary	Recommendation/ Follow-Up Actions	Recommendation/Follow-Up Action Summary	Recommended Implementation Date (Start)	Responsible Party
Source Area Sites						
CS-10/FS-24 Detail C and F	LUC/long-term protectiveness	Residual contaminant concentrations remain in soils/sediments.	Reassess soil data for UU/UE.	Complete a reassessment of Detail C EPH/VPH data and Detail F PAH, PCB, inorganic data and pursue UU/UE closure. If UU/UE closure cannot be achieved, then document LUC plan in an ESD.	November 2016	AFCEC
	Exposure assessment	The VI exposure pathway has not been assessed.	Complete VI evaluation.	Complete evaluation to assess potential for VI exposure following new guidance for petroleum hydrocarbon release sites.	November 2013	AFCEC
CY-2	LUC/long-term protectiveness	Removal action not yet completed.	Submit EE/CA and Action Memorandum for soil removal to achieve UU/UE.	The EE/CA will present removal action work conducted to date as background, and the remaining work necessary to complete the non-time-critical removal action for CY-2.	November 2013	AFCEC
FTA-2/LF-2	LUC/long-term protectiveness	Petroleum hydrocarbon-related contamination in groundwater was not directly addressed by the selected remedy presented in the ROD.	Submit Focused Feasibility Study	Prepare a Focused Feasibility Study to assess remedial alternatives for FTA-2 groundwater, submit a PP, and document the selected remedy in a ROD amendment. A component of the remedy for FTA-2 groundwater should include enforceable LUCs to ensure long-term protectiveness similar to the other IRP groundwater sites.	October 2013	AFCEC
	LUC/long-term protectiveness	Deed notification required per MassDEP Solid Waste Regulations (310 CMR 19.141)	File deed notification at Base Real Property Office to meet intent of 310 CMR 19.141 and document in ROD Amendment	A component of the institutional controls is to document the presence of a landfill at LF-2 through a deed notification per the MassDEP solid waste regulations (310 CMR 19.141). AFCEC, working with the base real estate office and the Commonwealth who owns the property, have been unable to determine whether a deed for this parcel is in existence. Therefore, the deed notification will be filed at the Base Real Property office which will meet the intent of the deed notification regulatory requirement. This action will be documented in the ROD Amendment for the FTA-2/LF-2 site.	January 2014	AFCEC
PFSA (FS-10/FS-11)	LUC/long-term protectiveness	Additional petroleum-related contamination in groundwater has been detected and further characterized since preparation of the ROD.	Submit Focused Feasibility Study.	Prepare a Focused Feasibility Study to assess remedial alternatives for PFSA groundwater, submit a PP, and document the selected remedy in a ROD amendment. A component of the remedy for PFSA groundwater should include enforceable LUCs to ensure long-term protectiveness similar to the other IRP groundwater sites	October 2013	AFCEC
	Exposure assessment	The VI exposure pathway should be re-assessed.	Complete VI evaluation.	Complete evaluation to assess potential for VI exposure following new guidance for petroleum hydrocarbon release sites.	January 2014	AFCEC

Table 1-4
Issue Description and Recommendations/Follow-Up Actions
Final 4th Five-Year Review, 2007-2012

Site Name	Issue Description	Issue Summary	Recommendation/ Follow-Up Actions	Recommendation/Follow-Up Action Summary	Recommended Implementation Date (Start)	Responsible Party
SD-4	LUC/long term protectiveness	Site data have been reassessed against updated RALs with the finding that UU/UE is supported for the majority of the SD-4 site. However, concentrations of inorganic compounds remain in soil and sediment above the updated RALs in the pond/wetland area (south of Reilly Road) and UU/UE conditions have not been met based on these data.	Prepare a RAR and ESD.	Prepare a RAR to document post-ROD actions completed at SD-4 and provide the basis for implementation of LUCs. Prepare an ESD to update RAOs and document the no further action decision based on post-ROD sampling and ecological risk analyses for current and future use for all areas except the pond/wetland area (south of Reilly Road) where LUCS are required for the remedy to be protective in the long-term.	October 2013	AFCEC
	Exposure assessment	The VI exposure pathway has not been assessed.	Complete VI evaluation.	Complete evaluation to assess potential for VI exposure.	November 2014	AFCEC
Groundwater Sites						
Ashumet Valley, CS-4, CS-10, CS-20, CS-21, CS-23, LF-1, and SD-5	Emerging contaminants	Emerging contaminants, specifically 1,4-dioxane and/or perfluorinated compounds (Ashumet Valley only)	Develop sampling and analysis plan	A sampling and analysis plan shall be submitted to the regulatory agencies to assess the possible presence of 1,4-dioxane (all listed plumes) and perfluorinated compounds (Ashumet Valley only).	October 2013 (1,4-dioxane); December 2014 (Perflourinated Compounds)	AFCEC
CS-4	Restoration timeframe discrepancy	The most recent groundwater model estimated restoration timeframe (2029) was longer than that presented in the ROD (2017). The prolonged restoration timeframe predicted by the groundwater model is the result of the retarded attenuation of PCE in a low hydraulic conductivity unit (where groundwater flow is minimal and field data indicate that PCE is not present), creating a modeling artifact that is commonly observed in MMR modeling results.	Re-run transport simulation and present results	In a manner similar to that performed at CS-20, the most recent CS-4 transport simulations will be re-run without loading PCE mass in low hydraulic conductivity units (where supported by data) to provide a more accurate and realistic estimated aquifer restoration timeframe.	May 2014	AFCEC
CS-10	Restoration timeframe discrepancy	The CS-10 CSM has changed since the ROD with an increase in the extent of TCE contamination in the In-Plume area. Preliminary transport modeling results indicate that the ROD restoration timeframe may not be achieved.	Submit draft ESD to document optimization of treatment system.	An optimization assessment of the CS-10 remedial system is underway which will assess the performance of the remedial system, determine whether operational improvements can be made, and update the restoration timeframe prediction for comparison to that presented in the ROD. An ESD presenting the updated CSM and the updated prediction for aquifer restoration timeframe will be completed.	March 2014	AFCEC
FS-12	Restoration timeframe discrepancy	The FS-12 CSM has changed since the ROD with an increase in the extent of EDB contamination in the core of the plume. Preliminary transport modeling results indicate that the ROD restoration timeframe may not be achieved, but the prolonged restoration timeframe may have resulted from using an outdated plume shell.	Update EDB plume shell and complete a remedial system optimization assessment.	An optimization assessment of the FS-12 remedial system will be performed with an updated EDB plume shell to evaluate the performance of the remedial system and assess/update the model-predicted restoration timeframe versus that presented in the ROD. If necessary at the conclusion of the optimization assessment, an ESD presenting the updated CSM and/or the updated prediction for aquifer restoration timeframe will be completed.	September 2013	AFCEC

Table 1-4
Issue Description and Recommendations/Follow-Up Actions
Final 4th Five-Year Review, 2007-2012

Site Name	Issue Description	Issue Summary	Recommendation/ Follow-Up Actions	Recommendation/Follow-Up Action Summary	Recommended Implementation Date (Start)	Responsible Party
LF-1/CS-23	Restoration timeframe discrepancy	The most recent groundwater model estimated restoration timeframe was longer than that presented in the ROD. The prolonged restoration timeframe may have resulted from using an outdated conservative plume shell.	Update plume shells and complete a remedial system optimization assessment.	An optimization assessment of the LF-1/CS-23 remedial system will be performed with updated plume shells to evaluate the performance of the remedial system and assess/update the model-predicted restoration timeframe versus that presented in the RODs. If necessary at the conclusion of the optimization assessment, an ESD presenting the updated prediction for aquifer restoration timeframe will be completed.	January 2014	AFCEC
	Increasing TCE concentration at CS-23 monitoring well	Increasing TCE concentrations observed at monitoring well 69MW1710A which is located downgradient and outside of the CS-23 remedial system capture zone	Re-assess plume boundary and LUC boundary and present results.	Re-assess plume boundary and LUC boundary based on June 2013 data as recommended in the *LF-1/CS-23 2012 Annual SPEIM Data Presentation Project Note*	October 2013	AFCEC
	Potential ecological impacts from system operation	Groundwater modeling predictions indicated potential drawdown of surface water levels at nearby wetlands/vernal pools.	Continue monitoring	Continue to collect ecological and hydrological data to assess the potential ecological impacts associated with the surface water drawdown due to operation of the LF-1/CS-23 remedial system.	Ongoing	AFCEC
SD-5	Restoration timeframe discrepancy	TCE concentrations have not yet consistently reached the MCL at SD-5 South as was expected at the time of remedy selection, primarily due to the presence of contamination in low hydraulic conductivity aquifer materials.	Prepare an ESD	An ESD will be prepared to update the aquifer restoration timeframe estimate for SD-5 South.	December 2013	AFCEC

Key:
AFCEC = Air Force Civil Engineer Center
CS = Chemical Spill
CSM = conceptual site model
CY = Coal Yard
EDB = ethylene dibromide
EE/CA = Engineering Evaluation/Cost Assessment
EPH = extractable petroleum hydrocarbon
ESD = explanation of significant difference
FS = Fuel Spill
FTA = Fire Training Area
IRP = Installation Restoration Program
LF = Landfill
LUC = Land Use Control
MassDEP = Massachusetts Department of Environmental Protection
MCL = Maximum Contaminant Level
PAH =polynuclear aromatic hydrocarbon
PCB = polychlorinated biphenyls
PCE = tetrachloroethene
PFSA = Petroleum Fuels Storage Area
PP = proposed plan
RAL = remedial action level
MMR = Massachusetts Military Reservation
RAO = Remedial Action Objective
RAR - remedial action report
ROD = Record of Decision
SD = Storm Drain
TCE = trichloroethene
VI = vapor intrusion
VPH =volatile petroleum hydrocarbon
UU/UE = unlimited use/unrestricted exposure

Table 1-5
Summary of Protectiveness Statements
Final 4th Five-Year Review, 2007-2012

Site Name	Section Number	Summary of Protectiveness Statement
Source Area Sites		
CS-10/FS-24 Detail A, B, D, E, G and H	4.1	**The remedies for CS-10/FS-24 source area Details A, B, D, E, G, H, and I are protective of human health and the environment.**
CS-10/FS-24 Detail C and F	4.1	**The remedies for CS-10/FS-24 source area Details C and F are protective of human health and the environment in the short-term under the current land use scenario**. However, for the remedies to be protective in the long-term it is recommended that existing site characterization data be re-evaluated to determine if UU/UE conditions have been met; if UU/UE closure cannot be supported for Details C and/or F, then either (i) conduct additional cleanup activities to levels that allow UU/UE; or (ii) issue a decision document implementing enforceable land use controls preventing uses for which the site may still pose an unacceptable risk under future uses that would ensure long-term protectiveness.
CY-2	4.2	**The remedy for the CY-2 source area is protective of human health and the environment in the short-term under the current land use scenario.** The no further action decision for this site currently protects human health and the environment because contaminant levels in soil are below cleanup levels that are protective of human health under current land use exposure scenarios. However, in order for the remedy to be protective in the long-term, the recommendations and follow-up actions specified in Section 4.2.7 need to be completed to ensure long-term protectiveness.
LF-1	4.3	**The remedy for the LF-1 source area is protective of human health and the environment.** Groundwater monitoring under the LF-1 SPEIM/LTM Program (discussed in Section 5.14) does not indicate the LF-1 source area is acting as a continuing source of groundwater contamination. Therefore, the landfill cap system at LF-1 is operating as expected. In addition, the LUCs are in place and are functioning as intended.
FTA-2/LF-2	4.4	**The remedy for the FTA-2/LF-2 source area is protective of human health and the environment in the short-term under the current land use scenario.** The remedy is protective in the short-term since access to the site is controlled by current flight line security measures which include fencing and 24-hour security that effectively limits potential human exposure to site contaminants. For the remedy to be protective in the long-term, it is recommended that additional remedial actions be implemented to address petroleum-related contamination in groundwater that was not directly addressed by the selected remedy presented in the ROD.
LF-7	4.5	**The remedy for the LF-7 source area is protective of human health and the environment.** The LUCs (i.e., fence and signage) at LF-7 are functioning as intended and the annual radiological surveys do not indicate the presence of radiation above background levels at the ground surface or at three feet above the ground surface within the fenced area. However, it is recommended that additional investigation and potentially remediation be completed at LF-7 with regards the presence of Radium-226 to determine whether the site can meet UU/UE site closure requirements.
PFSA (FS-10/FS-11)	4.6	**The remedy for the PFSA source area is protective of human health and the environment in the short-term under the current land use scenario.** The remedy is protective in the short-term since access to the site is controlled by current flight line security measures which include fencing and 24-hour security that effectively limits potential human exposure to site contaminants. Although groundwater contamination has been detected off-base, no private or municipal wells exist in the area and recent monitoring data indicate the contamination is not migrating any significant distance off base and municipal regulations are in place controlling exposure. For the remedy to be protective in the long-term, it is recommended that additional remedial actions be implemented to address petroleum-related contamination in groundwater that was not directly addressed by the selected remedy presented in the ROD.
SD-4	4.7	**The remedy for the SD-4 source area is protective of human health and the environment in the short-term under the current land use scenario.** Site data has been reassessed against updated RALs with the finding that UU/UE is supported for the majority of the SD-4 site. However, concentrations of inorganic compounds remain in soil and sediment above the updated RALs in the pond/wetland area (south of Reilly Road) and UU/UE conditions have not been met based on these data. This portion of the SD-4 site is located within installation boundaries and access to the area is unlikely due to its remoteness and nature (heavily vegetated wetland). However, institutional controls preventing uses for which the site may still pose an unacceptable risk should be implemented to ensure long-term protectiveness.

Table 1-5
Summary of Protectiveness Statements
Final 4th Five-Year Review, 2007-2012

Site Name	Section Number	Summary of Protectiveness Statement
Groundwater Sites		
AV	5.1	**The remedy for the AV groundwater plume is protective of human health and the environment.** The remedial systems are performing as expected. The LUCs are in place and are functioning as intended. Through the combination of the active treatment by the remedial systems and natural attenuation processes, groundwater cleanup levels are expected to be achieved within the timeframe approximated in the ROD which was considered reasonable given the particular circumstances of the site.
CS-4	5.2	**The remedy for the CS-4 groundwater plume is protective of human health and the environment.** The remedial system is performing as expected. The LUCs are in place and are functioning as intended. Through the combination of the active treatment by the remedial system and natural attenuation processes, groundwater cleanup levels are expected to be achieved within the timeframe approximated in the ROD which was considered reasonable given the particular circumstances of the site.
CS-10	5.3	**The remedy for the CS-10 groundwater plume is protective of human health and the environment.** The remedial system is performing as expected and the LUCs are in place and are functioning as intended. Through the combination of the active treatment by the remedial systems and natural attenuation processes, groundwater cleanup levels are expected to be achieved. However, due to a change in the CSM, the aquifer restoration timeframe may be longer than expected at the time of remedy selection and this will be further assessed. When an updated estimate of the aquifer restoration timeframe is available, it will be determined whether the RAO of restoring the aquifer in a reasonable timeframe is being met. Since the LUCs are in place and are functioning as intended to prevent exposure and there are no current plans to use the portion of the aquifer where CS-10 contamination is located for water supply, the remedy remains protective.
CS-19	5.4	**The remedy for the CS-19 groundwater plume is protective of human health and the environment.** Remediation is progressing as expected. The LUCs are in place and are functioning as intended. Through natural attenuation processes groundwater cleanup levels are expected to be achieved within the timeframe approximated in the ROD which was considered reasonable given the particular circumstances of the site.
CS-20	5.5	**The remedy for the CS-20 groundwater plume is protective of human health and the environment.** The remedial system is performing as expected. The LUCs are in place and are functioning as intended. Through the combination of the active treatment by the remedial system and natural attenuation processes, groundwater cleanup levels are expected to be achieved within the timeframe approximated in the ROD which was considered reasonable given the particular circumstances of the site.
CS-21	5.6	**The remedy for the CS-21 groundwater plume is protective of human health and the environment.** The remedial system is performing as expected. The LUCs are in place and are functioning as intended. Through the combination of the active treatment by the remedial system and natural attenuation processes, groundwater cleanup levels are expected to be achieved within the timeframe approximated in the ROD which was considered reasonable given the particular circumstances of the site.
CS-23	5.7	**The remedy for the CS-23 groundwater plume is protective of human health and the environment.** The remedial system is performing as expected. The LUCs are in place and are functioning as intended. Through the combination of the active treatment by the remedial systems and natural attenuation processes, groundwater cleanup levels are expected to be achieved within the timeframe approximated in the ROD which was considered reasonable given the particular circumstances of the site.
FS-1	5.8	**The remedy for the FS-1 groundwater plume is protective of human health and the environment.** The remedial system is performing as expected. The LUCs are in place and are functioning as intended. Through the combination of the active treatment by the remedial system and natural attenuation processes, groundwater cleanup levels are expected to be achieved within the timeframe approximated in the ROD, and revised in the Wellfield Design Report, which was considered reasonable given the particular circumstances of the site.

Table 1-5
Summary of Protectiveness Statements
Final 4th Five-Year Review, 2007-2012

Site Name	Section Number	Summary of Protectiveness Statement
FS-12	5.9	**The remedy for the FS-12 groundwater plume is protective of human health and the environment.** The remedial system is performing as expected and the LUCs are in place and are functioning as intended. Through the combination of the active treatment by the remedial systems and natural attenuation processes, groundwater cleanup levels are expected to be achieved. However, due to a change in the CSM, the aquifer restoration timeframe may be longer than expected at the time of remedy selection and this will be further assessed. When an updated estimate of the aquifer restoration timeframe is available, it will be determined whether the RAO of restoring the aquifer in a reasonable timeframe is being met. Since the LUCs are in place and are functioning as intended to prevent exposure and there are no current plans to use the portion of the aquifer where FS-12 contamination remains for water supply, the remedy remains protective.
FS-13	5.10	**The remedy for the FS-13 groundwater plume is protective of human health and the environment.** Remediation is progressing as expected. The LUCs are in place and are functioning as intended. Through natural attenuation processes, groundwater cleanup levels are expected to be reached over time and monitoring data indicate the contaminants are not migrating beyond the FS-13 area.
FS-28	5.11	**The remedy for the FS-28 groundwater plume is protective of human health and the environment.** The remedial system is performing as expected. The LUCs are in place and are functioning as intended. Through the combination of the active treatment by the remedial system and natural attenuation processes, groundwater cleanup levels are expected to be achieved within the timeframe approximated in the ROD, which was considered reasonable given the particular circumstances of the site.
FS-29	5.12	**The remedy for the FS-29 groundwater plume is protective of human health and the environment.** The remedial system performed for a shorter time than expected. The LUCs are in place and are functioning as intended. Now that active treatment no longer needed, groundwater cleanup levels are expected to be achieved through natural attenuation processes within the timeframe approximated in the ROD, which was considered reasonable given the particular circumstances of the site.
LF-1	5.13	**The remedy for the LF-1 groundwater plume is protective of human health and the environment.** The remedial system is performing as expected and the LUCs are in place and are functioning as intended. Through the combination of the active treatment by the remedial systems and natural attenuation processes, groundwater cleanup levels are expected to be achieved. However, there is some uncertainty in the model-predicted restoration timeframe that will be further assessed. When an updated estimate of the aquifer restoration timeframe is available, it will be determined whether the RAO of restoring the aquifer in a reasonable timeframe is being met. Since the LUCs are in place and are functioning as intended to prevent exposure and there are no current plans to use the portion of the aquifer where LF-1 contamination remains for water supply, the remedy remains protective.
SD-5	5.14	**The remedy for the SD-5 groundwater plume is protective of human health and the environment.** The LTM program is ongoing and the LUCs are in place and are functioning as intended. Through pre-ROD operation of the SD-5 remedial system and natural attenuation processes, groundwater cleanup levels have been achieved at SD-5 North and are expected to be achieved at SD-5 South. However, the timeframe to achieve aquifer restoration at SD-5 South will be longer than predicted in the ROD, primarily due to the presence of contamination in low hydraulic conductivity aquifer materials. Since the LUCs are in place and are functioning as intended and there are no current plans to use this portion of the aquifer for water supply, the remedy remains protective.

Key:

AV = Ashumet Valley
CS = Chemical Spill
CSM = conceptual site model
CY = Coal Yard
FS = Fuel Spill
FTA = Fire Training Area
LF = Landfill
LTM = long term monitoring

LUC = Land Use Control
PFSA = Petroleum Fuels Storage Area
RAL = remedial action level
RAO = remedial action objective
ROD = Record of Decision
SD = Storm Drain
SPEIM = System Performance and Ecological Impact Monitoring
UU/UE = unlimited use and unrestricted exposure

Table 1-6
EPA CERCLIS Operable Unit Number and Document Section
Final 4th Five-Year Review, 2007-2012

OU#	Site Name	Document Section
1	FS-12	5.9
2	CS-4	5.2
3	CS-3 (USCG)	NA
4	CS-1 (USCG)	NA
5	FTA-2/LF-2, PFSA/FS-10/FS-11, SD-2/ FS-6/FS-8, SD-3/FTA-3/CY-4, SD-4, and SD-5/FS-5	4.4, 4.6, 4.7
6	FS-1	5.8
7	LF-1 Landfill Cap	4.3
8	CS-10/FS-24 Source Area	4.1
9	Southwest Operable Unit	5.2, 5.5, 5.6, 5.10
10	FS-9	NA
11	CS-16/CS-17	NA
12	FS-17/FS-19	NA
13	SD-5 North	5.14
14	CS-10 Sandwich Road	5.3
15	Ashumet Valley Groundwater	5.1
16	LF-1 Groundwater	5.13
17	Eastern Briarwood	NA
18	Western Aquafarm	NA
19	FS-28 & FS-29	5.11 & 5.12
20	SD-5 South	5.14
21	CS-10 In-Plume	5.3
22	CS-10 Southwest	5.3
23	FS-2	NA
24	CS-19	5.4
25	CS-23	5.7

Key:
CERCLIS = Comprehensive Environmental Response, Compensation, and Liability Information System
CS = Chemical Spill
CY = Coal Yard
EPA = U.S. Environmental Protection Agency
FS = Fuel Spill
FTA = Fire Training Area
LF = Landfill
NA = Not applicable – Five Year Review not needed since site meets unrestricted use/unlimited exposure – (See Table 1-1b).
OU = Operable Unit
PFSA = Petroleum Fuel Storage Area
SD = Storm Drain
USCG = U.S. Coast Guard

Table 3-1
Summary of Site Inspections
Final 4th Five-Year Review, 2007-2012

IRP Source Area Site	Issues	Schedule for Corrective Actions	Responsible Party	Does Issue Affect Remedy Protectiveness?
CY-2	None	N/A	N/A	No
CY-10	None	N/A	N/A	No
FTA-2/LF-2	None	N/A	N/A	No
LF-1*	None	N/A	N/A	No
LF-7*	None	N/A	N/A	No
PFSA	None	N/A	N/A	No
SD-4	None	N/A	N/A	No

* AFCEC will continue annual inspections at these sites as part of the Land Use Control program.

Key:
CY = Coal Yard
FTA = Fire Training Area
LF = Landfill
N/A = not applicable
PFSA = Petroleum Fuel Storage Area
SD = Storm Drain

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
Region 1
5 Post Office Square, Suite 100
BOSTON, MA 02109

September 26, 2013

Jonathan S. Davis
Remediation Program Manager
HQ AFCEE/MMR
322 East Inner Road
Otis ANG Base, MA 02542-5028

Re: Response to Comment Letter on *Draft 4th Five-Year Review, 2007-2012 Massachusetts Military Reservation (MMR) Superfund Site, Otis Air National Guard Base, MA*

Dear Mr. Davis:

EPA has reviewed the Response to Comment Letter dated September 26, 2013 on the *Draft 4th Five-Year Review, 2007-2012 Massachusetts Military Reservation (MMR) Superfund Site, Otis Air National Guard Base, MA* dated July 2013. We accept all responses provided and approve the finalization of the document. If you have any questions, please do not hesitate to call me at (617) 918-1392.

Sincerely,

Robert Lim, Remedial Project Manager
Federal Facilities Superfund Section

cc: Lynne Jennings/EPA
Ronald Fein/EPA
Len Pinaud/MassDEP

DEPARTMENT OF THE AIR FORCE
AIR FORCE CIVIL ENGINEER CENTER
INSTALLATION RESTORATION PROGRAM
OTIS AIR NATIONAL GUARD BASE, MA 02542-5028

30 September 2013

AFCEC/JBCC
322 East Inner Road
Otis ANG Base MA 02542

Mr. Leonard Pinaud
Massachusetts Department of Environmental Protection
Southeast Region
20 Riverside Drive
Lakeville, MA 02347

Dear Mr. Pinaud

This Memorandum of Resolution (MOR) has been prepared following discussion with your agency regarding the Response to Comments letter issued by AFCEC/JBCC on 26 Sep 13 for the document entitled *Draft 4th Five Year Review, 2007-2012, Massachusetts Military Reservation (MMR) Superfund Site, Otis National Guard Base, MA* dated July 2013.

All responses, with the exception of MassDEP General Comment 1 and 11, were accepted. The resolution for comments 1 and 11 are addressed as follows:

Comment 1: MassDEP General Comment 1 referred to the comparison of current toxicity values against previously published toxicity values. After discussion, it was not clear in the five year review narratives for TCE (various sites) which toxicity values were being compared to each other (i.e. current toxicity values compared to those published in 20XX). To clarify the comparisons, the narrative will be adjusted at Question B for each applicable site to indicate the comparisons were made to toxicity values in place at the end of the last five year review (2007).

Comment 11: The response to MassDEP General Comment 11 included reference to a revised Table 1-5 which summarizes the Protectiveness Statements for the sites addressed in the Five Year Review. Row 3 of Table 1-5 addresses CY-2 and includes reference to a "no further action decision". All agencies have jointly agreed that the decision document for CY-2 was not fully executed. As such, CY-2 will not be subject to a protectiveness determination as part of this five year review and will be removed from Table 1-5.

Additionally, the language in Section 4.2, Coal Yard (CY) -2 will be adjusted to clarify that the 1988 decision document was not fully executed and no remedy has been put in place. Section 4.2 will be limited to a background discussion and a presentation of the recommendations and status from the third five year review regarding CY-2.

I look forward to your expedient acceptance of this MOR. If you have questions or require additional information, please feel free to contact me at 508-968-4670 x 4592.

Sincerely

JONATHAN S. DAVIS, P.E.
Remediation Program Manager

cc:
Bob Lim, EPA

MassDEP

Commonwealth of Massachusetts
Executive Office of Energy & Environmental Affairs

Department of Environmental Protection

Southeast Regional Office • 20 Riverside Drive, Lakeville MA 02347 • 508-946-2700

DEVAL L. PATRICK
Governor

RICHARD K. SULLIVAN JR.
Secretary

KENNETH L. KIMMELL
Commissioner

September 30, 2013

Mr. Jonathan S. Davis
Remediation Program Manager
HQ AFCEC/MMR
322 East Inner Road
Otis ANG Base, Massachusetts 02542

RE: **BOURNE**
Release Tracking Number: 4-0000037
Joint Base Cape Cod (JBCC)
Draft 4th Five-Year Review, 2007-2012,
Massachusetts Military Reservation (MMR)
Superfund Site, Otis Air National Guard Base,
MA - RCL, Concurrence

Dear Mr. Davis:

The Massachusetts Department of Environmental Protection (MassDEP) has reviewed the Memorandum of Resolution (the "MOR") dated September 30, 2013 issued for the document entitled **"Draft 4th Five-Year Review, 2007-2012, Massachusetts Military Reservation (MMR) Superfund Site, Otis Air National Guard Base, MA"** (the "Report"), dated July 2013. The MOR was prepared by the Air Force Civil Engineer Center (AFCEC) Installation Restoration Program (IRP) at the Joint Base Cape Cod (JBCC), formerly the Massachusetts Military Reservation (MMR).

MassDEP concurs with the MOR.

Please incorporate this letter into the Administrative Record for the Joint Base Cape Cod Superfund Site. If you have any questions regarding this letter, please contact me at (508) 946-2871 or Elliott Jacobs at (508) 946-2786.

Sincerely,

Leonard J. Pinaud, Chief
State & Federal Site Management Section
Bureau of Waste Site Cleanup

P/EJ/lm
4-0000037.IRP 5YR MOR.09-30-2013.docx

ecc: Philip Weinberg, Regional Director
Millie Garcia-Serrano, Deputy Regional Director
MassDEP Boston
MassDEP Southeast Regional Office
MMR Senior Management Board
MMR Cleanup Team
Upper Cape Boards of Selectmen
Upper Cape Boards of Health

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
Region 1
5 Post Office Square, Suite 100
BOSTON, MA 02109

September 30, 2013

Jonathan S. Davis
Remediation Program Manager
HQ AFCEE/MMR
322 East Inner Road
Otis ANG Base, MA 02542-5028

Re: 4th Five-Year Review, 2007-2012 Massachusetts Military Reservation (MMR) Superfund Site, Otis Air National Guard Base, MA

Dear Mr. Davis:

EPA Region 1 Office of Site Remediation and Restoration is writing to provide the Air Force Civil Engineer Center (AFCEC) with our assessment of the 4th five-year review at the Otis Air National Guard Base (also known as Massachusetts Military Reservation) Superfund Site (EPA ID MA2570024487). The five-year review process mandated by CERCLA Section 121 is designed to ensure that remedies originally selected remain protective over the long-term where hazardous substances are left on-site.

The *Draft 4th Five-Year Review, 2007-2012 Massachusetts Military Reservation (MMR) Superfund Site, Otis Air National Guard Base, MA* was issued in July 2013. The report focused on the time period from 2007 to 2012 and evaluated nine source areas and 14 groundwater plumes which are listed in the table below.

SOURCE AREA SITES	GROUNDWATER PLUMES	
Chemical Spill-10/Fuel Spill-24	Ashumet Valley	Fuel Spill-12
(UTES/BOMARC Details C and F)	Chemical Spill-4	Fuel Spill-13
Coal Yard-2	Chemical Spill-10	Fuel Spill-28
Landfill-1	Chemical Spill-19	Fuel Spill-29
Fire Training Area-2/Landfill-2	Chemical Spill-20	Landfill-1
Landfill-7	Chemical Spill-21	Storm Drain-5
Petroleum Fuels Storage Area	Chemical Sprill-23	
Storm Drain-4	Fuel Spill-1	

In light of recent EPA guidance on priorities for federal facility five-year reviews, EPA highlights the importance of five-year review reports that result in accurate, timely, and scientifically sound information on protectiveness in order for EPA to be able to fulfill its statutory responsibilities to assure that remedies at federal facility NPL sites are protective.

EPA's concurrence on a federal agency's finding of protectiveness in a five year review report demonstrates our mutual CERCLA responsibilities are carried out properly.

Since EPA has not received the final five-year review report as of the date of this letter, EPA is providing AFCEC with this letter as notification per EPA guidance of our concurrence with the protectiveness statements. Our concurrence is based on EPA's acceptance of the response to comment letter, dated September 26, 2013, which included revised text and tables, specifically Table 1-4 – Issues and Recommendations/Follow-up Actions, and Table 1-5 – Protectiveness Statements (See attachments). Also per guidance, EPA will be reporting to Congress the protectiveness determination for the site. We request submission of the final document within ten (10) days of receipt of this letter.

Further questions on this matter can be directed to Robert Lim, RPM, (617) 918-1392 or Lynne Jennings, MMR Team Leader, (617) 918-1210.

Sincerely,

Nancy Barmakian for

James T. Owens III, Director
Office of Site Remediation and Restoration

Attachments

cc: Mary Sanderson/EPA
Lynne Jennings/EPA
Len Pinaud/MassDEP

Table 1-4
Issue Description and Recommendations/Follow-Up Actions
Final 4th Five-Year Review, 2007-2012

Site Name	Issue Description	Issue Summary	Recommendation/ Follow-Up Actions	Recommendation/Follow-Up Action Summary	Recommended Implementation Date (Start)	Responsible Party
Source Area Sites						
CS-10/FS-24 Detail C and F	LUC/long-term protectiveness	Residual contaminant concentrations remain in soils/sediments.	Reassess soil data for UU/UE.	Complete a reassessment of Detail C EPH/VPH data and Detail F PAH, PCB, inorganic data and pursue UU/UE closure. If UU/UE closure cannot be achieved, then document LUC plan in an ESD.	November 2016	AFCEC
	Exposure assessment	The VI exposure pathway has not been assessed.	Complete VI evaluation.	Complete evaluation to assess potential for VI exposure following new guidance for petroleum hydrocarbon release sites.	November 2013	AFCEC
CY-2	LUC/long-term protectiveness	Removal action not yet completed.	Submit EE/CA and Action Memorandum for soil removal to achieve UU/UE.	The EE/CA will present removal action work conducted to date as background, and the remaining work necessary to complete the non-time-critical removal action for CY-2.	November 2013	AFCEC
FTA-2/LF-2	LUC/long-term protectiveness	Petroleum hydrocarbon-related contamination in groundwater was not directly addressed by the selected remedy presented in the ROD.	Submit Focused Feasibility Study	Prepare a Focused Feasibility Study to assess remedial alternatives for FTA-2 groundwater, submit a PP, and document the selected remedy in a ROD amendment. A component of the remedy for FTA-2 groundwater should include enforceable LUCs to ensure long-term protectiveness similar to the other IRP groundwater sites.	October 2013	AFCEC
	LUC/long-term protectiveness	Deed notification required per MassDEP Solid Waste Regulations (310 CMR 19.141)	File deed notification at Base Real Property Office to meet intent of 310 CMR 19.141 and document in ROD Amendment	A component of the institutional controls is to document the presence of a landfill at LF-2 through a deed notification per the MassDEP solid waste regulations (310 CMR 19.141). AFCEC, working with the base real estate office and the Commonwealth who owns the property, have been unable to determine whether a deed for this parcel is in existence. Therefore, the deed notification will be filed at the Base Real Property office which will meet the intent of the deed notification regulatory requirement. This action will be documented in the ROD Amendment for the FTA-2/LF-2 site.	January 2014	AFCEC
PFSA (FS-10/FS-11)	LUC/long-term protectiveness	Additional petroleum-related contamination in groundwater has been detected and further characterized since preparation of the ROD.	Submit Focused Feasibility Study.	Prepare a Focused Feasibility Study to assess remedial alternatives for PFSA groundwater, submit a PP, and document the selected remedy in a ROD amendment. A component of the remedy for PFSA groundwater should include enforceable LUCs to ensure long-term protectiveness similar to the other IRP groundwater sites	October 2013	AFCEC
	Exposure assessment	The VI exposure pathway should be re-assessed.	Complete VI evaluation.	Complete evaluation to assess potential for VI exposure following new guidance for petroleum hydrocarbon release sites.	January 2014	AFCEC

Table 1-4
Issue Description and Recommendations/Follow-Up Actions
Final 4th Five-Year Review, 2007-2012

Site Name	Issue Description	Issue Summary	Recommendation/ Follow-Up Actions	Recommendation/Follow-Up Action Summary	Recommended Implementation Date (Start)	Responsible Party
SD-4	LUC/long term protectiveness	Site data have been reassessed against updated RALs with the finding that UU/UE is supported for the majority of the SD-4 site. However, concentrations of inorganic compounds remain in soil and sediment above the updated RALs in the pond/wetland area (south of Reilly Road) and UU/UE conditions have not been met based on these data.	Prepare a RAR and ESD.	Prepare a RAR to document post-ROD actions completed at SD-4 and provide the basis for implementation of LUCs. Prepare an ESD to update RAOs and document the no further action decision based on post-ROD sampling and ecological risk analyses for current and future use for all areas except the pond/wetland area (south of Reilly Road) where LUCS are required for the remedy to be protective in the long-term.	October 2013	AFCEC
	Exposure assessment	The VI exposure pathway has not been assessed.	Complete VI evaluation.	Complete evaluation to assess potential for VI exposure.	November 2014	AFCEC
Groundwater Sites						
Ashumet Valley, CS-4, CS-10, CS-20, CS-21, CS-23, LF-1, and SD-5	Emerging contaminants	Emerging contaminants, specifically 1,4-dioxane and/or perfluorinated compounds (Ashumet Valley only)	Develop sampling and analysis plan	A sampling and analysis plan shall be submitted to the regulatory agencies to assess the possible presence of 1,4-dioxane (all listed plumes) and perfluorinated compounds (Ashumet Valley only).	October 2013 (1,4-dioxane); December 2014 (Perflourinated Compounds)	AFCEC
CS-4	Restoration timeframe discrepancy	The most recent groundwater model estimated restoration timeframe (2029) was longer than that presented in the ROD (2017). The prolonged restoration timeframe predicted by the groundwater model is the result of the retarded attenuation of PCE in a low hydraulic conductivity unit (where groundwater flow is minimal and field data indicate that PCE is not present), creating a modeling artifact that is commonly observed in MMR modeling results.	Re-run transport simulation and present results	In a manner similar to that performed at CS-20, the most recent CS-4 transport simulations will be re-run without loading PCE mass in low hydraulic conductivity units (where supported by data) to provide a more accurate and realistic estimated aquifer restoration timeframe.	May 2014	AFCEC
CS-10	Restoration timeframe discrepancy	The CS-10 CSM has changed since the ROD with an increase in the extent of TCE contamination in the In-Plume area. Preliminary transport modeling results indicate that the ROD restoration timeframe may not be achieved.	Submit draft ESD to document optimization of treatment system.	An optimization assessment of the CS-10 remedial system is underway which will assess the performance of the remedial system, determine whether operational improvements can be made, and update the restoration timeframe prediction for comparison to that presented in the ROD. An ESD presenting the updated CSM and the updated prediction for aquifer restoration timeframe will be completed.	March 2014	AFCEC
FS-12	Restoration timeframe discrepancy	The FS-12 CSM has changed since the ROD with an increase in the extent of EDB contamination in the core of the plume. Preliminary transport modeling results indicate that the ROD restoration timeframe may not be achieved, but the prolonged restoration timeframe may have resulted from using an outdated plume shell.	Update EDB plume shell and complete a remedial system optimization assessment.	An optimization assessment of the FS-12 remedial system will be performed with an updated EDB plume shell to evaluate the performance of the remedial system and assess/update the model-predicted restoration timeframe versus that presented in the ROD. If necessary at the conclusion of the optimization assessment, an ESD presenting the updated CSM and/or the updated prediction for aquifer restoration timeframe will be completed.	September 2013	AFCEC

Table 1-4
Issue Description and Recommendations/Follow-Up Actions
Final 4th Five-Year Review, 2007-2012

Site Name	Issue Description	Issue Summary	Recommendation/ Follow-Up Actions	Recommendation/Follow-Up Action Summary	Recommended Implementation Date (Start)	Responsible Party
LF-1/CS-23	Restoration timeframe discrepancy	The most recent groundwater model estimated restoration timeframe was longer than that presented in the ROD. The prolonged restoration timeframe may have resulted from using an outdated conservative plume shell.	Update plume shells and complete a remedial system optimization assessment.	An optimization assessment of the LF-1/CS-23 remedial system will be performed with updated plume shells to evaluate the performance of the remedial system and assess/update the model-predicted restoration timeframe versus that presented in the RODs. If necessary at the conclusion of the optimization assessment, an ESD presenting the updated prediction for aquifer restoration timeframe will be completed.	January 2014	AFCEC
	Increasing TCE concentration at CS-23 monitoring well	Increasing TCE concentrations observed at monitoring well 69MW1710A which is located downgradient and outside of the CS-23 remedial system capture zone	Re-assess plume boundary and LUC boundary and present results.	Re-assess plume boundary and LUC boundary based on June 2013 data as recommended in the *LF-1/CS-23 2012 Annual SPEIM Data Presentation Project Note*	October 2013	AFCEC
	Potential ecological impacts from system operation	Groundwater modeling predictions indicated potential drawdown of surface water levels at nearby wetlands/vernal pools.	Continue monitoring	Continue to collect ecological and hydrological data to assess the potential ecological impacts associated with the surface water drawdown due to operation of the LF-1/CS-23 remedial system.	Ongoing	AFCEC
SD-5	Restoration timeframe discrepancy	TCE concentrations have not yet consistently reached the MCL at SD-5 South as was expected at the time of remedy selection, primarily due to the presence of contamination in low hydraulic conductivity aquifer materials.	Prepare an ESD	An ESD will be prepared to update the aquifer restoration timeframe estimate for SD-5 South.	December 2013	AFCEC

Key:
AFCEC = Air Force Civil Engineer Center
CS = Chemical Spill
CSM = conceptual site model
CY = Coal Yard
EDB = ethylene dibromide
EE/CA = Engineering Evaluation/Cost Assessment
EPH = extractable petroleum hydrocarbon
ESD = explanation of significant difference
FS = Fuel Spill
FTA = Fire Training Area
IRP = Installation Restoration Program
LF = Landfill
LUC = Land Use Control
MassDEP = Massachusetts Department of Environmental Protection
MCL = Maximum Contaminant Level
PAH =polynuclear aromatic hydrocarbon
PCB = polychlorinated biphenyls
PCE = tetrachloroethene
PFSA = Petroleum Fuels Storage Area
PP = proposed plan
RAL = remedial action level
MMR = Massachusetts Military Reservation
RAO = Remedial Action Objective
RAR - remedial action report
ROD = Record of Decision
SD = Storm Drain
TCE = trichloroethene
VI = vapor intrusion
VPH =volatile petroleum hydrocarbon
UU/UE = unlimited use/unrestricted exposure

Table 1-5
Summary of Protectiveness Statements
Final 4th Five-Year Review, 2007-2012

Site Name	Section Number	Summary of Protectiveness Statement
		Source Area Sites
CS-10/FS-24 Detail A, B, D, E, G and H	4.1	**The remedies for CS-10/FS-24 source area Details A, B, D, E, G, H, and I are protective of human health and the environment.**
CS-10/FS-24 Detail C and F	4.1	**The remedies for CS-10/FS-24 source area Details C and F are protective of human health and the environment in the short-term under the current land use scenario**. However, for the remedies to be protective in the long-term it is recommended that existing site characterization data be re-evaluated to determine if UU/UE conditions have been met; if UU/UE closure cannot be supported for Details C and/or F, then either (i) conduct additional cleanup activities to levels that allow UU/UE; or (ii) issue a decision document implementing enforceable land use controls preventing uses for which the site may still pose an unacceptable risk under future uses that would ensure long-term protectiveness.
CY-2	4.2	**The remedy for the CY-2 source area is protective of human health and the environment in the short-term under the current land use scenario.** The no further action decision for this site currently protects human health and the environment because contaminant levels in soil are below cleanup levels that are protective of human health under current land use exposure scenarios. However, in order for the remedy to be protective in the long-term, the recommendations and follow-up actions specified in Section 4.2.7 need to be completed to ensure long-term protectiveness.
LF-1	4.3	**The remedy for the LF-1 source area is protective of human health and the environment.** Groundwater monitoring under the LF-1 SPEIM/LTM Program (discussed in Section 5.14) does not indicate the LF-1 source area is acting as a continuing source of groundwater contamination. Therefore, the landfill cap system at LF-1 is operating as expected. In addition, the LUCs are in place and are functioning as intended.
FTA-2/LF-2	4.4	**The remedy for the FTA-2/LF-2 source area is protective of human health and the environment in the short-term under the current land use scenario.** The remedy is protective in the short-term since access to the site is controlled by current flight line security measures which include fencing and 24-hour security that effectively limits potential human exposure to site contaminants. For the remedy to be protective in the long-term, it is recommended that additional remedial actions be implemented to address petroleum-related contamination in groundwater that was not directly addressed by the selected remedy presented in the ROD.
LF-7	4.5	**The remedy for the LF-7 source area is protective of human health and the environment.** The LUCs (i.e., fence and signage) at LF-7 are functioning as intended and the annual radiological surveys do not indicate the presence of radiation above background levels at the ground surface or at three feet above the ground surface within the fenced area. However, it is recommended that additional investigation and potentially remediation be completed at LF-7 with regards the presence of Radium-226 to determine whether the site can meet UU/UE site closure requirements.
PFSA (FS-10/FS-11)	4.6	**The remedy for the PFSA source area is protective of human health and the environment in the short-term under the current land use scenario.** The remedy is protective in the short-term since access to the site is controlled by current flight line security measures which include fencing and 24-hour security that effectively limits potential human exposure to site contaminants. Although groundwater contamination has been detected off-base, no private or municipal wells exist in the area and recent monitoring data indicate the contamination is not migrating any significant distance off base and municipal regulations are in place controlling exposure. For the remedy to be protective in the long-term, it is recommended that additional remedial actions be implemented to address petroleum-related contamination in groundwater that was not directly addressed by the selected remedy presented in the ROD.
SD-4	4.7	**The remedy for the SD-4 source area is protective of human health and the environment in the short-term under the current land use scenario.** Site data has been reassessed against updated RALs with the finding that UU/UE is supported for the majority of the SD-4 site. However, concentrations of inorganic compounds remain in soil and sediment above the updated RALs in the pond/wetland area (south of Reilly Road) and UU/UE conditions have not been met based on these data. This portion of the SD-4 site is located within installation boundaries and access to the area is unlikely due to its remoteness and nature (heavily vegetated wetland). However, institutional controls preventing uses for which the site may still pose an unacceptable risk should be implemented to ensure long-term protectiveness.

Table 1-5
Summary of Protectiveness Statements
Final 4th Five-Year Review, 2007-2012

Site Name	Section Number	Summary of Protectiveness Statement
Groundwater Sites		
AV	5.1	**The remedy for the AV groundwater plume is protective of human health and the environment.** The remedial systems are performing as expected. The LUCs are in place and are functioning as intended. Through the combination of the active treatment by the remedial systems and natural attenuation processes, groundwater cleanup levels are expected to be achieved within the timeframe approximated in the ROD which was considered reasonable given the particular circumstances of the site.
CS-4	5.2	**The remedy for the CS-4 groundwater plume is protective of human health and the environment.** The remedial system is performing as expected. The LUCs are in place and are functioning as intended. Through the combination of the active treatment by the remedial system and natural attenuation processes, groundwater cleanup levels are expected to be achieved within the timeframe approximated in the ROD which was considered reasonable given the particular circumstances of the site.
CS-10	5.3	**The remedy for the CS-10 groundwater plume is protective of human health and the environment.** The remedial system is performing as expected and the LUCs are in place and are functioning as intended. Through the combination of the active treatment by the remedial systems and natural attenuation processes, groundwater cleanup levels are expected to be achieved. However, due to a change in the CSM, the aquifer restoration timeframe may be longer than expected at the time of remedy selection and this will be further assessed. When an updated estimate of the aquifer restoration timeframe is available, it will be determined whether the RAO of restoring the aquifer in a reasonable timeframe is being met. Since the LUCs are in place and are functioning as intended to prevent exposure and there are no current plans to use the portion of the aquifer where CS-10 contamination is located for water supply, the remedy remains protective.
CS-19	5.4	**The remedy for the CS-19 groundwater plume is protective of human health and the environment.** Remediation is progressing as expected. The LUCs are in place and are functioning as intended. Through natural attenuation processes groundwater cleanup levels are expected to be achieved within the timeframe approximated in the ROD which was considered reasonable given the particular circumstances of the site.
CS-20	5.5	**The remedy for the CS-20 groundwater plume is protective of human health and the environment.** The remedial system is performing as expected. The LUCs are in place and are functioning as intended. Through the combination of the active treatment by the remedial system and natural attenuation processes, groundwater cleanup levels are expected to be achieved within the timeframe approximated in the ROD which was considered reasonable given the particular circumstances of the site.
CS-21	5.6	**The remedy for the CS-21 groundwater plume is protective of human health and the environment.** The remedial system is performing as expected. The LUCs are in place and are functioning as intended. Through the combination of the active treatment by the remedial system and natural attenuation processes, groundwater cleanup levels are expected to be achieved within the timeframe approximated in the ROD which was considered reasonable given the particular circumstances of the site.
CS-23	5.7	**The remedy for the CS-23 groundwater plume is protective of human health and the environment.** The remedial system is performing as expected. The LUCs are in place and are functioning as intended. Through the combination of the active treatment by the remedial systems and natural attenuation processes, groundwater cleanup levels are expected to be achieved within the timeframe approximated in the ROD which was considered reasonable given the particular circumstances of the site.
FS-1	5.8	**The remedy for the FS-1 groundwater plume is protective of human health and the environment.** The remedial system is performing as expected. The LUCs are in place and are functioning as intended. Through the combination of the active treatment by the remedial system and natural attenuation processes, groundwater cleanup levels are expected to be achieved within the timeframe approximated in the ROD, and revised in the Wellfield Design Report, which was considered reasonable given the particular circumstances of the site.

Table 1-5
Summary of Protectiveness Statements
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Site Name	Section Number	Summary of Protectiveness Statement
FS-12	5.9	**The remedy for the FS-12 groundwater plume is protective of human health and the environment.** The remedial system is performing as expected and the LUCs are in place and are functioning as intended. Through the combination of the active treatment by the remedial systems and natural attenuation processes, groundwater cleanup levels are expected to be achieved. However, due to a change in the CSM, the aquifer restoration timeframe may be longer than expected at the time of remedy selection and this will be further assessed. When an updated estimate of the aquifer restoration timeframe is available, it will be determined whether the RAO of restoring the aquifer in a reasonable timeframe is being met. Since the LUCs are in place and are functioning as intended to prevent exposure and there are no current plans to use the portion of the aquifer where FS-12 contamination remains for water supply, the remedy remains protective.
FS-13	5.10	**The remedy for the FS-13 groundwater plume is protective of human health and the environment.** Remediation is progressing as expected. The LUCs are in place and are functioning as intended. Through natural attenuation processes, groundwater cleanup levels are expected to be reached over time and monitoring data indicate the contaminants are not migrating beyond the FS-13 area.
FS-28	5.11	**The remedy for the FS-28 groundwater plume is protective of human health and the environment.** The remedial system is performing as expected. The LUCs are in place and are functioning as intended. Through the combination of the active treatment by the remedial system and natural attenuation processes, groundwater cleanup levels are expected to be achieved within the timeframe approximated in the ROD, which was considered reasonable given the particular circumstances of the site.
FS-29	5.12	**The remedy for the FS-29 groundwater plume is protective of human health and the environment.** The remedial system performed for a shorter time than expected. The LUCs are in place and are functioning as intended. Now that active treatment no longer needed, groundwater cleanup levels are expected to be achieved through natural attenuation processes within the timeframe approximated in the ROD, which was considered reasonable given the particular circumstances of the site.
LF-1	5.13	**The remedy for the LF-1 groundwater plume is protective of human health and the environment.** The remedial system is performing as expected and the LUCs are in place and are functioning as intended. Through the combination of the active treatment by the remedial systems and natural attenuation processes, groundwater cleanup levels are expected to be achieved. However, there is some uncertainty in the model-predicted restoration timeframe that will be further assessed. When an updated estimate of the aquifer restoration timeframe is available, it will be determined whether the RAO of restoring the aquifer in a reasonable timeframe is being met. Since the LUCs are in place and are functioning as intended to prevent exposure and there are no current plans to use the portion of the aquifer where LF-1 contamination remains for water supply, the remedy remains protective.
SD-5	5.14	**The remedy for the SD-5 groundwater plume is protective of human health and the environment.** The LTM program is ongoing and the LUCs are in place and are functioning as intended. Through pre-ROD operation of the SD-5 remedial system and natural attenuation processes, groundwater cleanup levels have been achieved at SD-5 North and are expected to be achieved at SD-5 South. However, the timeframe to achieve aquifer restoration at SD-5 South will be longer than predicted in the ROD, primarily due to the presence of contamination in low hydraulic conductivity aquifer materials. Since the LUCs are in place and are functioning as intended and there are no current plans to use this portion of the aquifer for water supply, the remedy remains protective.

Key:
AV = Ashumet Valley
CS = Chemical Spill
CSM = conceptual site model
CY = Coal Yard
FS = Fuel Spill
FTA = Fire Training Area
LF = Landfill
LTM = long term monitoring
LUC = Land Use Control
PFSA = Petroleum Fuels Storage Area
RAL = remedial action level
RAO = remedial action objective
ROD = Record of Decision
SD = Storm Drain
SPEIM = System Performance and Ecological Impact Monitoring
UU/UE = unlimited use and unrestricted exposure